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THE EDINBURGH JOURNAL OF SCIENCE.

ART. I.—*Historical Eloge of* LOUIS FRANÇOIS ELISABETH BARON RAMOND, * Honorary Counsellor of State, Commander of the Legion of Honour, Chevalier of St Michel, Member of the Academy of Sciences, of the Academy of Medicine, and of several other learned Societies. By M. Le Baron CUVIER, Perpetual Secretary to the Academy of Sciences. †

IN this biographical account of one of our most ingenious colleagues, I would have wished to confine myself to such of his works as are connected with the objects of the Academy, and to have spoken to you only of the natural philosopher, the botanist, and the geologist; but this separation, become so difficult in our day for the greater number of the academicians, is entirely impossible in the case of him of whom I am about to speak. In him the philosopher, the man of fortune, the legislator, were united in indissoluble ties; it was often his duties which led him to his observations; and if he has given a better description of the Pyrenees than any other, it was because political hatreds obliged him to take refuge there. His situation at the head of a department interesting to geology, enabled him to bring to perfection the mensuration of heights; in a

* Translated from the French.

† M. Ramond in his youth was known by the name of *Carboniere*.

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word, it is in the details of an agitated life that we shall find the necessary commentary on the most learned of his works. You will not be astonished then to hear me recal the events of general history in which M. Ramond took a part, and of which he had been the victim, because they are almost always the events which were the cause of his discoveries.

From his very infancy, from his origin itself, we perceive in some degree the germ of what he has been. His father, Pierre Ramond, treasurer extraordinary of the wars in Alsace, was originally from the south of France. His mother, Maria Eisentraut, belonged to a German family on the left bank of the Rhine; and it was partly the persecutions exercised against the protestants, and partly the melancholy devastations which the French armies committed at the two seizures of the Palatinate in 1674 and in 1689, which had fixed these two families in Alsace; so that uniting in himself the lively and ardent nature of the inhabitants of the South, with that disposition to meditation, that perseverance, so common among the German people, that M. Ramond derived from the recollections of his ancestors the horror of an arbitrary government, and the consequences which it brings along with it, even when, as it rarely happens, it is in the hands of a monarch so penetrating, so well informed, in his affairs, and of such greatness of mind as Louis XIV. undoubtedly was.

Strasburg was perhaps the place most favourable to the developement of these dispositions. On taking possession of that city, France had guaranteed to them the preservation of their internal government, and there were found there all the complicated forms of the republics of the middle age. Its University, organized like those of Germany, and consequently affording the most varied and extended instruction, enjoyed great celebrity from the talents of Schoepflin for those studies which relate to diplomacy and public law. Here were assembled the sons of the greatest houses of Germany and the north; and M. Ramond had for the companions of his studies the men who have performed in our day the most conspicuous parts in Europe.

The various branches of law were little less than an amusement to a mind so active, and he found time to study Natural

An idea may be formed of the liveliness of the impressions which he experienced, from the notes to his translation of the Letters of Coxe upon Switzerland. With what truth he there paints both those beautiful valleys, where the surface of the globe had already attained an equilibrium, and its rugged rocks whose ruins still threatened the abode of man, and those eternal glaciers, the insurmountable limits to every species of organization! with what delight he speaks of the charms of a country life! with what penetration he sees through the intrigues and the passions which agitate those petty democracies! and nevertheless, how he makes these simple shepherds respectable, and how he shows them to be full of sense and of justice in the exercise of the highest powers.* This manner of describing what he had seen, in notes on the works of another, arose entirely from his modesty. He thought himself too young to write a book of his own, but his readers thought otherwise. The lively pace of the commentator pleased them more than the grave step of the author. We really think that we are travelling in Switzerland with M. Ramond, and what perhaps never happened before, his French translation was re-translated into English, with his additions, and in that form it met with greater success in England than the original itself. Coxe, however, as we may believe, was not so well pleased as the public; and in a more enlarged edition which he published some time afterwards, he did not even mention the name of the author who had so powerfully contributed to the success of the first.

The letters on Switzerland had made M. Ramond known at Paris. They were there surprised that a young Alsacian could write French with such elegance and power, and could display on so many different subjects such boldness and judgment. They were still more so, when, in the most brilliant circles, he showed himself the equal of men who were most celebrated for their conversational talents. The genius for society has always been in France the first of passports, and it was then more than ever that the spirit of party had not begun to make war upon it. Hence M. Ramond had only to choose

* Lettres de M. Coxe à M. W. Melmoth, sur l'etat politique, civile, et naturel de la Suisse, traduites de l'Anglais, et augmentées des observations faite[illegible]me pays, par le traducteur. 2 vols. 8vo. Paris, Belin, 1781.

peace for more than a century, the great spent their time from their infancy in effeminacy; and, never supposing that anything would threaten their security, they had no other occupation than that of varying their pleasures. Too often when they had tasted of everything, the extraordinary and the marvellous could alone rouse their exhausted spirits, and the first impostor who held out to them hopes or new sensations was received with enthusiasm.

We know but too well to what extent the Cardinal de Rohan allowed himself to be involved in such a snare.

"In 1781 the juggler Cagliostro arrives at Strasburg, preceded, accompanied, and followed by the poor whom he relieved, the sick whom he attended gratuitously, and the believers whom he illuminated with supernatural lights." It is in these terms that M. Ramond himself paints his arrival in a memoir which we have now before us. "This noisy cortege, adds he, celebrate him without ceasing; nobody knows whence he came, who he is, from what source he derives the wealth which he lavishes, and by what secret power he wields so unlimited an empire over their minds. Every one has his conjectures, advances assertions, and every thing is more strange than another." The Cardinal wished to see him, to entertain him, and, what is still more unaccountable, a prince of the Church, a powerful lord, who had exercised the highest functions of diplomacy, an academician, connected with our most distinguished men, becomes, in some conferences, the friend, the disciple, and the slave of the son of a tavern-keeper of Palermo. He cannot even part with him, and when his duties require a separation, he wishes to have near him a faithful agent to keep up their communications, and it is M. Ramond whom he desires to fill this situation. Several times he sent him to him at Strasburg, Lyons, and Basle. He wished even that he would assist the Sicilian in his operations, and become a sort of assistant in his laboratory.

Was it a natural deference to a master whom he loved that induced M. Ramond to second the desires of the Cardinal? Was it the hope of penetrating into some of the secrets which this singular man appeared to possess? Was it even the idea alone, excusable perhaps in so young man, that he would be

amused with his mysterious operations? Or in short, did Cagliostro really influence his imagination, and deceive him with the same illusions as he did so many others? To these questions we cannot make a reply; but this much is certain, that M. Ramond confessed that he became one of the most intimate friends of the great magician;—that he became the depositary of his receipts, and the witness of several of his miracles. He did not even conceal from his friends that he had seen, or that he believed he had seen, very extraordinary things; but when he was pressed on the subject, he broke off the conversation and refused any further explanation. Now that the charlatannerie of Cagliostro is no longer a problem, we can only conjecture, that, penetrating as M. Ramond was, the juggler had contrived to conceal even from him a part of the springs with which he worked. We should at least believe that these proofs cured him of his disposition to mysticism, for nobody was farther removed from it than he was in the last years of his life; and the contemptuous warmth with which he expressed himself respecting the attempts of this kind which have been renewed in our times, proves him to be a man who knew well where to place his confidence.

The irregular life of the Cardinal, his imprudent connections, conducted him, as every body knows, to a catastrophe more frightful than could have been imagined. Shamefully duped by persons the most contemptible, he had the inconceivable folly to believe that the queen had charged him with the clandestine acquisition of diamonds of great value; and the still more inconceivable folly of delivering these diamonds to his pretended coadjutors. A minister who had been long his enemy did not scruple to give to these follies the most criminal aspect; and this great lord, this man of wit, who had already made himself ridiculous by becoming the dupe of a charlatan, finished his career by being associated with the vilest persons in Paris, in the common accusation of an infamous act of swindling.

In this frightful disaster his true friends, who had not been able to tear him in time from these dreadful connections, resumed all their zeal in order to save him. Among the mass of papers which a man in the situation of a cardinal necessarily preserved, there must necessarily have been many foreign

to his trial, which would have furnished to his persecutor other pretexts for completing his ruin. In two hours after his arrest, M. Ramond succeeded in communicating with him in spite of his keeper, in obtaining possession of his papers, and in destroying every thing which could have complicated his case.

With regard to the trial itself, the great object was to prove that the diamonds had been stolen by those whom the cardinal believed to be charged with returning them to the queen. For this purpose it was necessary to trace them, and it was soon found that they had passed into England. M. Ramond resolved to go there instantly. In vain did the Minister, the Cardinal's enemy, who had got notice of his design, try to arrest him on the road by a *Lettre de Cachet.* He had obtained secret information of it from M. de Malesherbes, and having taken a circuitous route, he arrived safely in England.

The nature of his enterprize, as he himself said, put him in communication with the most degraded beings on both sides of the channel; but he also found in the society of men of honour frequent opportunities of escaping from this pestiferous atmosphere, and of seeing England in the most favourable point of view. An account of his journey was written, and doubtless it would have possessed all the interest of that which he performed in Switzerland and the Pyrenees; but unfortunately it was carried off from him in 1814, as we shall presently see.

By means of his sagacity and exertions, M. Ramond succeeded in establishing, by the clearest testimony, how and by whom the diamonds were carried off and sold in London. This was the most complete justification of the Cardinal in the principal point of the affair; but in order to rouse his courage and arrange his defence, it became indispensable that he should be made acquainted with these discoveries. Detained in the Bastile with the most rigorous secrecy, nobody was permitted to approach him; not even one of his relations durst hazard an imprudent step. M. Ramond risked himself on this occasion; he entered the Bastile without the knowledge of the governor, and as it were in spite of him. At last the case came to be tried, and he had the pleasure of seeing the Cardinal and Ca[illegible] freed from every charge, and of bringing down m[illegible]ent on those who had involved this unfortu-

nate prince in so abominable a labyrinth. But while this decision absolved him in the eyes of the public, it gave only a new virulence to the hatred with which he was persecuted. At first confined in his Abbey of Chaise-Dieu, in the most rugged mountains of Auvergne, he is received there by the monks only with a mock respect; the dreaded minister is still there, and the prior is his lieutenant. Spies beset the exile; —insolence is on every face, and he has reason to dread the poniard and the poison. M. Ramond alone continues near him, watches over his safety, and gives him every consolation. These rigours did not begin to subside till the disturbances in 1787 made the government reflect on its position; and so difficult is it to renounce a bad course, that it is always with a slow step that we return to justice. The Cardinal was not recalled, but he was permitted to retire into another of his Abbeys at Marmoutier-les-Tours, a rich country, where he experienced a kindness which, since his misfortunes, had been unknown to him.

M. Ramond, who had now become less necessary to him, availed himself of this opportunity of travelling among the Pyrenees, which he had long desired to compare with the Alps, and it was during that journey that he composed his first account of it which appeared at the beginning of 1789.* It is neither less animated nor less intellectual than his *Observations on Switzerland.* It contains ingenious remarks on the glaciers and on the equilibrium of heat and cold which preserve their limits. The people who inhabit the valleys were also the objects of his study. He inspires us with sympathy for those persecuted races known under the name of Cagots, and he inquires into their origin. But what is particularly interesting for the sciences, we find here the first germs of his General Theory of Mountains as well as his ideas on the Laws by which their vegetation is regulated,—germs, however, which did not assume their scientific form till some years afterwards, during his compulsory residence in the

* Observations faites dans les Pyrénées, pour servir de suite á des observations sur les Alpes insérées dans une traduction des Lettres de Coxe sur la Suisse, 2 vol. in 8vo. Paris, Belin, 1789.

same country, which on this occasion he had visited only from curiosity.

M. Ramond had experienced in his relation with the Cardinal de Rohan all that was disagreeable in the favour of the great—he had still to experience that of the favour of the people. The Cardinal, delivered from exile in consequence of the revolution of the 14th July, and sent as a deputy from the clergy of his diocese to the National Assembly, was henceforth free from all his persecutions, and it was no longer a point of honour that his former servants should remain attached to his person. M. Ramond now established himself at Paris. Connected as he was with most of those men who had concurred in the new state of things, it was difficult for him to remain a simple spectator, and scarcely had he appeared in a section, when his eloquence and extent of information made him a person of importance. He was placed, as he himself playfully remarks in his memoirs, among the number of those small powers who thought that they could carry through the revolution, but who were soon dragged along by the revolution itself. Continually at the conferences and cabinet meetings, from that of Condorcet to that of Mirabeau, of the Hotel de La Rochefoucault to the Hotel de Ville, or engaged in the clubs, sometimes with the friends of good, and sometimes with the spirits of mischief, he saw the latter continually advancing in spite of the efforts of the former. He was at last chosen a deputy to the first legislature, and here there were new and more constant combats,—combats in which he had constantly against him the imprudent friends of the throne as well as its blind adversaries.

From its first sittings he was found to conjure the assembly, though in vain, not to introduce religious discussions into debates already sufficiently animated: He called for toleration; he proposed that the ecclesiastics, whether sworn or not, should be chosen freely by the communes, and that they should all receive salaries. On a later occasion he attempted to adjourn the consideration of the laws against emigrants; he at least resisted the proposal that they should all suffer the same punishment without regard to their conduct to the mother country. On another occasion he endeavoured to prevent the disbanding

en masse of the king's guard, that violent step in which it was easy to see the prelude to the overthrow of the throne. Sometimes his language is that of the day, the only one which was intelligible, but his conclusions were in favour of justice and reason. Vain efforts. To men in the heat of passion nothing can appear reasonable and just but the objects of their desire, and often the most eloquent discourses only exasperated them more in an opposite direction. It happened even that in those circuitous means, in those difficult manœuvres to which they were obliged to resort who strove to put off a catastrophe, M. Ramond had the misfortune to involve himself in a proceeding which, contrary to his intention, accelerated the progress of it. M. Delessart, Minister of Foreign Affairs, had by an imprudent communication drawn upon himself the hatred of the ruling party. The minister of war, M. de Narbonne, an honest but frivolous man, committed an imprudence of another kind by declaiming publicly against his colleague, and thus exposing the division which reigned in the ministry. The king irritated, dismissed him. His friends, who considered him a necessary support to the throne, believed that the time had come when it was necessary to serve the cause of royalty in spite of itself, by urging the assembly to testify its regret at this removal, and M. Ramond, their organ, proposed even to declare that the other ministers had lost the confidence of the nation. But it was one thing to make a proposition and another to calculate the result of it. The stormy debate which followed took a turn quite contrary to the views of those who had provoked it: In place of a resolution, the effect of which was confined to bring back the king to counsellors who could save him, the party who wished to destroy him demanded the impeachment of M. Delessart. An insidious report, prepared before hand by the famous Brissot, and the existence of which was not even known to the authors of the first proposition, supported this demand. No answer was ready. The fatal decree was passed, and from that time the unfortunate monarch could find only faithless or pusillanimous ministers, and no serious obstacles any longer stopped the audacity of his enemies.

On the disgraceful day of the 20th June, the voice of M. Ra-

mond was still heard in favour of order and the laws, but, as on other occasions, it was raised in vain. Exhausted by anxiety, and thrown into despair by the fruitlessness of his efforts, he was taken ill, underwent a painful operation, and was reduced to so alarming a state that his physicians made him set out for Bareges some days before the 18th of August. He thus escaped from the first danger; but the vengeance of the triumphant faction was not slow in pursuing him. He saw this himself, and took refuge in the remotest recesses of the mountains, sustaining himself on the milk and black bread of the shepherds. Arrested at last on the 15th January 1794, and thrown into the prison at Tarbes, it was owing to the ingenious humanity of a soldier who knew his reputation, that he was not immediately dragged before the revolutionary tribunal.

M. Lomet, a distinguished officer of engineers, who was charged with the establishment of the hospitals of the army of the Pyrenees, pretended that he required for this purpose to consult a person well acquainted with the country. He was thus permitted to confer with M. Ramond in his prison, and to carry to him some relief. Lomet even solicited his liberation from Carnot, but he judiciously replied to him, *he is too fortunate in being forgotten.* There was also a stratagem used in his favour by M. Monestier, an envoy from the convention, who had been charged with bringing to Paris those whom the triumvirs had proscribed. He found some pretexts for delaying his departure, and this gained for him the 9th Thermidor. His life was then safe, but still he was not liberated. He was not discharged from prison till the 9th November, and he came out of it deprived of everything. In his prison he had already been in a great measure supported by the labours of a sister, who, with admirable courage, hastened to his relief, and devoted herself to his fate. When once free, he resumed, either from necessity or taste, that kind of life which previous to his arrest he had led for his safety, and this precarious condition did not terminate till 1796, when he obtained the situation of professor of natural history in the central school for the upper Pyrenees, which was established at Tarbes.

M. Ramond filled this situation for four years,—the happiest perhaps of his life. The youth whom misfortune had

thrown into this small town, formed an interesting audience. The same eloquence which distinguished him in the world, and in the tribune animated him in the chair. It particularly inspired him when he traversed with his pupils those fine mountains whose wonders he expounded to them; and when by their assistance he explored them with new care, not even a stone escaped him, and not even a plant was neglected. He ascended thirty-five times the *Pic du Midi* of Bareges; and having failed in two trials in 1797, to ascend the peak called *Mont Perdu*, the highest of the chain, he resumed, and succeeded in the attempt in 1802. It was from this kind of life that a contemporary poet, in a laudatory poem, denominated him *un savant chamois.*

To these repeated journeys we owe the third work of M. Ramond, which, under the too limited title of *Voyage au Mont-Perdu*,* presents in reality a general theory of the chain of the Pyrenees, equally new and important for geology.

By an arrangement opposite to that which is observed in all other great chains, the flanks of these mountains present very few shells: it is only the summits which abound with the debris of organized bodies, and hence numerous objections had been drawn against the laws which Pallas and Saussure had recognized in the structure of mountains. M. Ramond found indeed calcareous beds of shells on the summit of the chain; but a lucky observation showed him that the strata of these calcareous beds of shells dipped to the south, and in an ulterior survey he discovered the schists and the granites which run beneath the calcareous strata. Returning farther to the north he saw these schists and granites arranged in parallel lines, but inferior to the great crest. Farther north still he again found the calcareous strata resting in parallel lines on the granites and schists; but these last lines were the least elevated of all. Henceforth order was, in his opinion, again established. The granite forms, as every where else, the axis of the chain; but there is a singular inequality of level

* Voyage au Mont-Perdu, et dans la partie adjacente de Hautes Pyrenées, par M. Ramond. Paris, Belin, 1801, 1 vol. 8vo; et Voyage au Sommet du Monte-Perdu, extrait du *Journal des Mines.* Bossange, 1803, broch. in 8vo.

between the collateral crests of the north and those of the south; and upon the latter we meet in ascending the same series of beds which on the other we follow in descending. *Mont-Perdu* is the first of calcareous mountains, as Mont-Blanc is the first of granite mountains, and, though less elevated, it does not yield to Mont-Blanc either in the aspect of the ruins which surround it, or in all the imposing spectacles which characterize the most terrible revolutions. "We seek even in vain," says M. Ramond, "in the granite mountains, for those simple and impressive forms, those large beds which stretch out into walls, which bend into amphitheatres, which form themselves into terraces, and which shoot up into turrets where the hands of giants seem to have applied the line and the plummet."

Imagination, as we see, always animated his style, but in place of misleading him, as it does so many others, it is a character quite peculiar to his writings; it seems but to give the truth with more reality, and to transport the reader more completely to the spot, and to place before him whatever the author is desirous of representing.

It is also to his travels among the Pyrenees that we owe not only some new plants * which M. Ramond discovered, but also general views on the vegetation of mountains, and on the comparison of the zones with the climates of our hemisphere, which, already begun by Linnæus, has become in our day, under the pen of Humboldt, Decandolle, and Mirbel, the subject of such interesting works.

M. Ramond himself attached great value to these questions. They formed his earliest and his latest studies; and a short time before his death he republished them in an extended form in a Memoir on the *Vegetation of the Pic du Midi*, which was the last of his works. † More animated, and still more picturesque on this subject than on the other objects of his research, his style often rises to the highest eloquence. Every person admired in one of our public meetings the dis-

* Plantes inedites des Pyrenées. *Bulletin des Sciences*, No. 41 and 42, An viii. No. 43 and 44, An ix.

† Mémoire sur la Vegetation du Pic du Midi de Bagneres de Bigorre, lu à l'Academie des Sciences, le 16 Jan. et le 13 Mars 1826. It is printed in the Memoirs of the Academy.

course * in which he gave an account of the history of those living plants, which "on the fields of perpetual ice, under the double shelter of the snow of the earth, do not perhaps see the light above ten times in a century, and then perform their circle of vegetation in the short space of a few weeks, only to resume their sleep in a winter of several years; and of those common plants, separated in a manner from the rest, but whose presence is explained by the debris of a rock or of a hut. Man in bringing there his flocks, brings with him without knowing it, the birds and insects of the valleys. He returns to it perhaps no more, but these wild regions have received in an instant the indelible impress of his power."

That same ardour which he had infused into his style, animated also his mode of speaking, and it was not less interesting to hear him read his productions, than to be present at those animated conversations in which he made his ideas original by expressions more original still. Many a time did he produce this effect among ourselves, when about 1800 he returned from the foot of the Pyrenees. The man who was soon to arrive at the supreme power, and who was then often present at our meetings, had no sooner heard him than he felt how important it would be to attach to his government a person of such powers. At the establishment of the prefectures he offered him one of them; but in these times it was still permitted to refuse a favour, and M. Ramond, appointed to the legislative body by the department where he had enjoyed so many pleasures, preferred a situation which separated him only for six weeks from his beloved mountains. He was not, however, forgotten, and the less so as it was readily perceived that he was not a man who would allow his thoughts to be dictated to him, and that whatever were his sentiments, he knew how to impress them most effectually on the minds of others. Too skilful not to penetrate the flimsy veil which yet covered the projects of his master, too frank to conceal any thing which he did perceive, he was not inferior in the energetic vivacity of his wit to a celebrated lady, (Madame de

* Printed in vol. iv. of the *Annales du Museum et Histoire Naturelle*, p. 395.

Stael) who was soon compelled to quit Paris. It was wished also to remove him, but a vice-president of the legislative body could not be treated like a foreign lady. The plan was delayed till his time was finished, and in 1806, he was appointed to the prefecture of the Puy de Dome, in terms which left him no choice, and hence he was in the habit of saying that he was a prefect by Lettre de Cachet.

It was perhaps to this circumstance as much as to his good sense that he owed the merit, then very rare, and which his fellow magistrates largely appreciated,—that of not administering his office to excess. We know that in his department they still retain an honourable recollection of the tranquillity which individuals enjoyed at a time when so many pretexts were found for vexatious scrutinies. Besides, he was far from neglecting that which really interested the public, and he has left a fine monument of his administration in the hydraulic works of Mont-d'Or, one of the most useful and best frequented of our bathing-places.

But in point of duration, what are the acts of the wisest administration compared with the least service rendered to the sciences? What M. Ramond did for them in the Puy de Dome, will certainly be that of which the world will preserve the longest recollection. Whether by a fortunate accident, or by an express intention, such as frequently entered into the views of him by whom he was appointed, he found himself at the head of a country the most classical in geology, of that Auvergne where craters of all ages,—currents of lava in all directions,—basalts of all forms, unfold to the naturalist in the clearest language, the history of volcanos, and its epochs during hundreds of centuries anterior to all human history. He found himself especially in those very places where Pascal had made the admirable discovery of the mensuration of heights by the barometer. * The ideas which he had entertained from his first excursions in the Pyrenees, and the necessity of this instrument for geology, and on the improvements of which its use was susceptible, awakened in him with new strength.

* It is well known that Pascal, after his first experiment made on the steeple of St Jaques-du-haut-Pas, at Paris, engaged his brother-in-law, Perrier, who lived at Clermont, to repeat the experiment on the mountain of th Dome.

The mercury is supported in the barometer by the weight of the atmosphere: in proportion as we ascend, the column of air which presses upon it diminishes, it falls in the tube, and if the air were everywhere of the same density and the same temperature, nothing would be easier than to know by its fall how high we had ascended: But it is not so. The air being elastic, the superior compresses the inferior strata, and, in proportion as we ascend, the density and weight of the air decrease in a geometrical progression. The mercury then falls less for an equal height, in proportion as this height is taken at a higher elevation,—a second variation, which, if it were the only one, would occasion only very simple operations. It would have been sufficient to multiply the difference of the logarithms of the observed heights of the mercury by a number which expressed in metres the elevation, which, at a given position, at the level of the sea for example, corresponded to a determinate fall of the mercury. But we should still obtain from this rude results: the differences of heat both of the air and of the mercury; the differences in the humidity of the atmosphere; the decrease of the force of gravity arising from the distance to which we are removed from the centre of the earth, and even from the increase of the convexity of the globe towards the equator, are so many circumstances which it is necessary to take into account if we wish to arrive at any precision. The late M. de Laplace had introduced all the operations which these circumstances require into a general formula, which was a rigorous expression of them, but the application of which presupposed the positive determination of the coefficients belonging to each, and particularly the principal coefficient; but in his first trials he had fixed this coefficient too low, so that all heights calculated from the formula were beneath the real height, as given by trigonometrical measurements or by levelling. M. Ramond,* availing himself of some heights measured accurately by geometers, and having made

* Mémoires sur la formule barometrique de le Mecanique Celeste, et les distribution de l'atmosphere qui en modifient les propriétés, augmentés d'une instruction élémentaire et pratique destinée à servir de guide dans l'application du barometre à la mesure des hauteurs. Clermont-Ferrand, 1811, in 4to.

barometrical observations at the same points with the minutest attention, showed how much the coefficient should be increased. He determined with the same care the other numbers, and he also paid attention to a number of momentary circumstances which disturbed the accuracy of the observations, and the influence of which he learned to avoid. Among this number, are the prevailing winds, the daily variations of the barometer, the facility with which the thermometer, especially in mountains, experiences from the earth,—an impression different from that which the heat of the air would produce if acting alone. The appreciation of all these effects required journeys, experiments, and calculations without end; and M. Ramond put himself to so much trouble about it, that a wit one day asked, if the prefect intended to measure his conscripts by the barometer. The truth is, that the barometer has become by his means a geodetic instrument, which gives to geographers and engineers, with great economy of time and labour, the heights of high grounds and summits, too much neglected in ancient charts, and which even permits them to employ these heights as bases for measuring horizontal distances. It is particularly an instrument of the first importance to the geologist, whom it enables to take the level of a formation wherever it appears, and thus to assign its absolute position in spite of all the depositions by which it may be masked.

M. Ramond has himself derived great help from the barometer, in completing the history of the two most interesting chains of Auvergne, the Monts-Dome and the Monts-Dores. * The simple operation of levelling had led him to discover between the lavas of different ages remarkable differences of structure. The most ancient appear to have preserved their fluidity well for a long time, and to have been carried to much greater distances from the mouths which discharged them. They comprehend not only the basalts properly so called, but porphyries, petrosilex, clinkstones, which are not less than basalts the products of an igneous fusion, and which often divide themselves, like the basalts, into columnar prisms. The more recent

* "Nivellement barometrique des Monts-Dores, et des Monts-Domes, disposé par ordre des terrains," presented to the Institute on the 24th and 31st July 1813.

lavas are not so much elevated, and are of a less varied nature. They all rest on a vast plateau of granite, or are deposited in its interstices. They have been discharged from its entrails, or from the parts of the globe situated below it, and these different soils, and their different stages, have each plants, animals, and culture peculiar to themselves. M. Ramond traces the history of them, and supports it by a determination of more than 400 heights obtained by his method *.

It was thus that M. Ramond employed in Auvergne those moments which the duties of his office left at his own disposal; and he felt that the duties which so many others could have performed as well as himself, fettered too much the use of those talents which belonged to him. In January 1813 he was allowed to retire, and he came to reside near Paris, with the view of devoting the rest of his life to the education of his son, and to the final redaction of his researches in Physics, Geology and Botany. The memoirs of his life were also to form one of the occupations of his old age, and this would doubtless not have been the least interesting. But, during the invasion of 1814, his journals, his correspondence, all the materials which he had collected, were destroyed in one day by the Cossacks :—of the labours of forty years there remained to him only the recollections. A powerful distraction of his thoughts, or a work of severe labour, was the only possible resource under such a misfortune, and M. Ramond again engaged himself in his affairs. Appointed Master of Requests on the 24th August 1815, he was charged in January 1816, along with M. Lechat, one of his colleagues, with the liquidation of English claims,—a delicate operation, in which it was necessary to defend the interests of the treasury against foreigners, whose position enabled them to strain the exactions of treaties. A perfect knowledge of English, the charm of his conversation, the natural ascendancy which his high reputation gave him, were of such use, that, out of 3,500,000 francs of rentes, which had been voted for the liquidation of this part of our engagements, the com-

* Application des nivellements executés dans la departement du Puy-de-Dome à la Geographie Physique de cette portie de la France. This Memoir was read to the Institute on the 7th August 1813.

mission of which he was a member, had only to pay 2,950,000 francs, and yet, in spite of the reductions and numerous rejections which he had to pronounce, no complaint was addressed to the respective governments. The late M. Le Duc de Richelieu declared, that it was the most successful of all the commissions of liquidation, and this enlightened judge of what belonged to delicacy and national honour, hastened to request the King to appoint M. Ramond counsellor of state on the ordinary service. He was raised to this situation on the 14th June 1818. The public, astonished to see him obtain so late a recompence, to which his talents and his services seemed to call him, was still more surprised to see him lose it before three years had expired. Since 1822 his name no longer appeared in the list of acting counsellors, and soon after, it was struck out of the number of honorary counsellors. What was the cause of this? Nobody, I believe, knows any thing of the matter. This much, however, is certain, that his removal is one of those which have made us the more desire and bless the ordonnance which shall prevent the repetition of it in future.

M. Ramond supported this last disgrace as he did the other events to which his lot had exposed him. Neither the gaiety of his conversation, nor the forcible energy of his expressions were affected by it. One would have said that age increased the ardour of his discourse and of his affections; and even in his last moments, his slight proportions, his keen temperament, the vivacity of his movements, recalled the painter of the mountains, at the same time that the manner in which he characterized the personages who appeared in the horizon of politics, or upon that of science and literature, announced the man, who, in learning to judge of his equals, had availed himself of all the phases of an adventurous life.

A chronic inflammation of the intestines made him pass his last days in acute pain. He died on the 14th May 1827, leaving behind him only one son by his marriage with Madame Cherin, the widowed daughter of our respectable colleague M. Dacier. His place in the Academy has been filled by M. Berthier, engineer of mines, so celebrated by his numerous analyses of minerals.

ART. II.—*Description of a New Steam-Engine without a Boiler.* By ALEXANDER SCOTT, Esq. Communicated by the Inventor.

IN the first volume of the *Edinburgh Journal of Science*, first series, page 267, the following notice was given: That in 1823 a model of a steam-engine was made and wrought without a boiler, and experiments were made with it in presence of several in the immediate neighbourhood, and afterwards in presence of two ingenious mechanics, (brothers of the name of Halliday, who carry on a small foundry near Haddington) who were invited to witness the rapid production of steam without the aid of a boiler. The plan appeared to them very simple and secure from danger, and the experiments so satisfactory, that they soon afterwards commenced mounting a high pressure engine upon this plan, and of a power sufficient for their own works. It was added, that when finished, if it wrought to expectation, a description of the engine would be sent for insertion in the *Edinburgh Journal of Science*. Before describing the manner of working the engine without a boiler, it may be proper to state the cause which occasioned so much loss of time in the formation of it. All the parts of the engine were executed by one of the brothers at his spare hours; and while he was carrying on the different parts, he was twice attacked with a rheumatic fever, which made him long unfit for work of any kind.

When water of a low temperature is forced by a pump into a small generator placed over a fire, every stroke of the pump tends to lower the temperature of the whole body of the water. This led to devise a generator by which water of a low temperature can be forced into it without lowering the temperature of the hottest part of the water. In constructing a generator with that property, two truly flat circular patterns of wood were made, having each corresponding projecting parts. In the one pattern a continued spiral groove was cut from the centre to nearly its circumference, the other pattern was left plain. Fig. 1, Plate I. represents the one, and Fig. 2 the other. Both these patterns were made twenty-one inches

in diameter, exclusive of the projecting parts. The spiral grooved pattern was one inch and three quarters in thickness, and the plain pattern one inch and a quarter thick, as also were the projecting parts of both patterns. The spiral groove was cut half an inch in depth, half an inch wide at bottom, and seven-eighths of an inch at top. The ridge between the grooves was left half an inch in breadth at top, and seven-eighths of an inch at bottom. From these two patterns iron casts were taken. The faces of both these cast-iron plates were made truly flat, and a very small chiseled groove was cut along the middle of the ridge between the grooves, and a corresponding chiseled groove was cut in the inch and quarter thick plate. These two plates were then cemented together by means of well-prepared iron cement, part of it filling the chiseled grooves in both plates; the projecting parts *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, Figs. 1 and 2, were bolted together by screw bolts, five-eighths of an inch square, made of the best iron; in all fifteen bolts, as marked by the small square bolt holes in Figs. 1 and 2; the projecting parts of Fig. 1 being all, except that marked *h*, one and a quarter of an inch in thickness, which leaves a space of half an inch between the projecting parts of the two plates, for the more effectually screwing the plates close together. These two plates when thus joined form only the one-half of the generator, as there is another half almost in every respect similar to be placed perpendicularly over the one described; having a strong cast-iron pillar with flanges, as represented by Fig. 3, placed in the centre between the halves: These flanges are strongly secured by four screw bolts to each of the halves of the generator. The centre pillar is twelve inches in height and four and a half inches in diameter, with a bore up its centre of one inch and a quarter in diameter.

Fig. 4 represents a section of the generator answering to the description already given, placed in a furnace, of which a section is also given.

The generator is supported in the furnace by cast-iron brackets represented by Fig. 5 and 6, built into the sides of the furnace for the projecting parts of the generator to rest on, where F, Fig. 4, is the fire place, A the ash pit, and C par[illegible] chimney. R represents part of the pipe that leads

from the force pump to the generator, whence the water circulates round and round the spirals from the circumference to the centre of the under half of the generator, ascends the centre pillar P, then circulates outwards from the centre of the upper half of the generator to its circumference, and escapes by the pipe S, that leads to the cylinder of the engine. The pipe T is the one that conveys part of the escape steam from the cylinder into the chimney. This generator works a small high pressure engine, of which the following is a short description :—

The frame of it is of cast-iron, of the form of the upper part of Mr Maudslay's portable engine with its parallel motion. The piston of the cylinder is six inches in diameter, and the length of the cylinder permits the piston rod to make a stroke of seventeen inches. The steam is permitted to enter the cylinder alternately above and below the piston by means of a spring slide valve wrought by the engine, and has a stroke of one and two-eighths of an inch. The axis of the fly wheel cranks, &c. is two inches and a quarter square ; the rounded parts two and one-eighth inches in diameter. The fly is seven hundred weight, and six feet in diameter. In the steam-pipe that leads from the generator to the cylinder, there is a three-way cock introduced, with a branch proceeding from it to the hot well of the engine, by which the steam may be permitted either to pass to the cylinder, or by one-third turn of the cock into the hot well of the engine. This three-way cock answers for stopping or starting the engine. As there is no space in this kind of generator, as in common engine boilers, for the steam to condense or expand, the common throttle valve is not applicable to this kind of generator ; but in place of it, a spring slide valve is introduced in the steam-pipe between the three-way cock and generator, with a branch from it communicating with the branch pipe that leads between the three-way cock and hot well. This slide valve is raised and lowered against a very acute angled aperture by means of centrifugal balls, so as to permit a necessary regulating quantity of steam to escape into the hot well. In the pipe by which the steam escapes from the cylinder into the chimney, there is a branch to the hot well ; in this branch there is a cock by which the tempe-

rature of the water in the hot well is regulated. The forcing pump is wrought by the engine, and supplies the generator with water from the hot well. In a side vessel that communicates with the hot well, there is a forcing pump wrought by hand for starting the engine. Into this vessel additional water enters to supply the engine, and where the height of the water in the hot well is regulated. As the engine is intended to work different kinds of machinery, either together or separately, different powers are required.

To produce these several powers, there is a short branch from the steam-pipe near the generator, that reaches to a convenient place, where a steel guard safety valve is placed. On the lever of this safety valve, the safety valve weight is to be hung at divisions marked on it answering to the power required, and a corresponding length of stroke is also to be given to the forcing pump of the engine.

The engine was first publicly tried in January 1828 before it was connected with machinery of any kind; but that it might meet with some resistance, a friction bar of iron with a considerable pressure was applied to the periphery of the fly wheel, when the engine made eighty-eight double strokes per minute.

The engine was lately tried connected with grinding and turning-lathe machinery, and at the same time it wrought cast-iron rollers bruising bleas for fire. Although the bleas were very irregularly fed into the rollers, yet the engine continued to make sixty-four double strokes per minute. A greater number might have been obtained; but from the irregular manner the bleas was fed in, there was reason to fear that the main axis of the engine might give way.

On the bottom and sides of vessels that have been long used for boiling fresh water, a calcareous crust is generally formed more or less in thickness.

It is proposed, if it shall be found that the spiral grooved generators are liable to be incrusted in this manner, that a water-tight cistern be placed somewhat higher than the generator. This cistern is to be connected with the upper part of the generator by a pipe and stop-cock. There is also to be a branch pipe [illegible] steam-pipe close to the under part of the gene-

rator, with a particular stop-cock, that when open, it shall cut off the communication between the generator and the side valves. Let this cistern be filled brimful with water, and the cock at the bottom of the generator left open. If the cock of the cistern be opened the whole water of the cistern will escape through the generator; and if the time it takes to escape be observed by a pendulum or stop-second watch, the repetition of this experiment at any time will show if the passage through the generator be contracted since last experiment. Should it be found to be so, it is then proposed to fill the generator with diluted muriatic acid, taking care to cut off the communication between it and the slide valves. After letting it remain in the generator a sufficient time, it is then to be washed out with warm water poured into the above-mentioned cistern. If the cistern be filled brimful it will serve to ascertain if the passage be clear, by observing the time it takes to pass through the generator. Repetitions of these experiments will undoubtedly free the generator of all calcareous matter. But as none of the strong acids act on the crust formed by sea water, it is therefore proposed to proceed in the same manner with diluted sulphuric acid, taking care never to give time for much crust to form by sea water, so that by the diluted sulphuric acid partly acting on the iron, it shall effect the removing of an imperfect crust produced from salt water; the generator to be always thoroughly washed out with warm water.

The length of time that this engine has been in constructing, gave ample time to devise improvements. Several were proposed, but few of them were thought of in time to be introduced without making material alterations on the parts made; such as improvements in the manner of constructing generators of greater strength, but of which it is unnecessary to lengthen this paper with a description. However, one thing may be mentioned, as it would add to the improvement of the engine. In place of working the escape steam slide valve by the immediate action of the centrifugal balls, it was proposed that the axis of a bevelled wheel should be turned by the machinery of the engine, and which is to turn other two bevelled wheels on one axis. These two last mentioned wheels are neither of them to be fixed to the axis, but both to slip round freely

upon it, turning in contrary directions as they receive motion from the opposite sides of the first mentioned wheel. A locking stub box is fitted upon the axis between the two wheels, and can, by moving it one way or the other, be made to lock either of the wheels to the axis at the same time that it leaves the other disengaged. It is proposed that the centrifugal balls shall shift this stub box back or forward as their centrifugal motion shall be affected by the velocity that they receive from the engine. The axis of these two wheels is proposed to be so connected with the escape steam slide valve, that on its turning one way round it shall raise the valve to let the steam escape, and by turning the contrary way it shall depress the valve that less may escape; and it is further proposed, that there shall be spring sockets on the axis of the first wheel, to prevent any part giving way when the valve is fully wrought up or down. In like manner it is proposed to work the furnace damper for regulating the heat of the fire.

The engine, as now completed, is a handsome piece of well-finished accurate workmanship, and performs its part admirably. The young man who made all the principal parts of the engine is a self-taught mechanic, and merits the highest praise for the ingenuity, elegance, and perfect workmanship which he has displayed upon it.

Ormistoun, *September* 1829.

Art. III.—*Account of the Natural Productions of Staten Island and Cape Horn.* By Captain W. H. B. Webster, R. N. In a Letter to John Barrow, Esq. F. R. S., &c.

SIR,

As you have been pleased to take so great an interest in our voyage, I beg to lay before you some observations and remarks more immediately connected with the southern portion of it. Commencing with Staten Island and connecting Cape Horn with it, as far as respects plants and vegetables, there being a perfect identity, I will endeavour to specify the principal products thereof, having regard, in the statement I have now the

honour of making, to practical results and utility. A paper to this effect has been delivered to Captain Foster, with a collection of seeds, plants, and specimens, to exemplify and corroborate the statements I have made. It is almost unnecessary to state, that the plants of these regions will easily and readily adapt themselves to the climate of England, requiring, however, rather a moist soil. The vegetation of Staten Island and Cape Horn, singularly enough, is composed almost entirely of evergreens, among which, both from frequency and size, the beech ranks first. I presume it to be the *Fagus Antarctica;* but having no systematic work with the character of the species, I am precluded from speaking in this respect with absolute certainty; but this is of less consequence, as the specimens themselves will afford the means of its being identified. The evergreen beech clothes the country with forests of perpetual verdure. When young it is a very pretty and ornamental shrub. It attains to a size of considerable magnitude. The wood is not worthy of much praise. The bark contains some tannin, and afforded us the means of converting the seal skins into leather with very good effect. The leather has an aromatic and agreeable smell. This beech is beset with a very singular parasitic shrub, which engrafts itself on the branches in a peculiar manner. I know not the name; but there are numerous specimens of it in fructification and seeds. Around the summit of the trunk, and on some of the larger branches, are frequently a congeries of orange-coloured globular smooth fungi of the size of a small apple. When mature it opens on the surface, and displays a honey-combed cellular structure. The fungi are slimy, mucilaginous, and insipid. Where these fungi are attached to the tree it becomes extremely knotted and tuberculated, forming a very large hard knob. The wood of this evergreen beech in decay undergoes a most singular change, becoming throughout of a fine bright verdigrise green, retaining its colour against the action of every agent, alkaline or acid. It is not affected in any way by light or moisture. I pulverized some and tried it as a paint, for which it seems admirably adapted, affording a good colour for any work, being both durable and elegant. This decayed wood is not luminous in the dark. It does not universally undergo this conversion,

for none of it was found by the Adventure's officers on Terra del Fuego; and they were surprised when I showed it to them. Large masses of this green wood are transmitted home as specimens, and blocks of it have been given by me to Captain Foster. There is another species of beech in these regions which is deciduous. It is more common at Cape Horn than at Staten Land, where it is very rare. The change of colour of its leaf gives the usual charm of autumnal scenery. The *Juncus grandiflorus*, or Fuegian rush, appears worthy of being introduced to your notice from its valuable qualities, which are such as to induce me to hope that the introduction of it to our own country will prove both advantageous and beneficial. It makes most beautiful and excellent baskets, exceedingly strong, durable, and elegant. The specimen of the Fuegian basket procured at Cape Horn from the Indian tribe, which I have deposited with Captain Foster, will confirm all that I have said in its favour. It almost equals India cane mats; and may, in the hands of our ingenious countrymen, be turned to many purposes, as the manufacture of baskets, mats, brooms, and probably hats. The flower of this rush is by no means inelegant. It grows in precisely similar situations to our own rush, which it may very justly supplant by its superior merits. I have gathered abundance of seeds, in order that it may be tried either by the Society of Arts or Board of Agriculture, if you should think fit to permit it. It may not be irrelevant to mention, that the stem of this rush is very sweet, and when dry it resembles coarse hay. How far it can in any way be rendered available as fodder in cases of emergency, must be left to proper and competent judges. The ashes of the rush are very alkaline.

I am much indebted to the Horticultural Society for two reams of brown paper, for the preservation of seeds and plants. I have not been negligent of their interest in this respect, and have gathered and preserved every seed and plant that came within my reach. They are in an excellent state of preservation, and have been given to Captain Foster for forwarding to the Admiralty. Among the more immediately useful ones I beg to enumerate the *Berberis microphylla*, a free and copious bearer. [illegible] berries are intermediate between a gooseberry

and a grape, of a pleasant and agreeable flavour, fit for tarts, puddings, or table use. It may be cultivated with advantage in our gardens as an agreeable variety and pretty little bush.

The *Chelone ruelloides*, and *Androsace spathulata* or Fuegian Auricula, are flowers of considerable beauty and interest, worthy of the gayest parterre. The seeds of these were very scarce.

The elegant myrtle-like shrub *Arbutus aculeata* cannot be sufficiently admired. It is a most pleasing evergreen, and cannot fail of being a general favourite. It is very hardy, and bears its berries through the winter. I have sent some seeds of the celery of these regions, as it appeared to be a far more vigorous and luxuriant plant than our own ; and, should it improve on cultivation equally with ours, it will be an acquisition. It is very large and fine, equal to our cultivated celery in many cases.

The Balsam plant of Staten Island forms elegant cushion-like knolls, from the leaves of which a fragrant resinous juice exudes, having very much the properties of copaiva. It concretes naturally into a solid resin ; and, should it assimilate in character to copaiva, it will prove an admirable addition to the Materia Medica, as being capable of administration in the form of pills, whereby it would supersede the late attempts to obtain the resin of copaiva.

The coral-like berries of Hamadryas contain a good colouring principle analogous to Annotta. It is not altered either by acids or alkalies. If the dye should be of the least value the plant will thrive on waste bogs and moors. I could enumerate the particulars of other plants. The sea-weeds of Staten Island are really gigantic. I found one with very acid properties, which I thought rather an anomaly ; and others certainly contain iodine.

While on the subject of plants I may introduce Shetland, naked, bare, and destitute as it is even of a vestige. A shred or two of a most diminutive moss, requiring almost a microscopic eye to discover it, is very scarce and rare, being found only in very few spots. A lichen identical with the one on the hills of Cape Horn, as the specimens attached to their respective rocks will show, comprise the botany of Shetland, ex-

cepting the sea-weeds, of which there is a paucity. A small parenchymatous one yielded a very agreeable mucilage like gum-arabic, and with sugar would form no bad jelly for a dessert in these regions of desolation. Of the red snow and the *Aurora Australis*, I will leave others to speak, having seen neither the one nor the other, though much interested respecting them. I have sent the bottle with the red snow water, such as it is; but I think ours is a fallacy. The geological specimens are numerous and ample. They are done up in separate bags for their respective places. I have a singular and unique one from Shetland, which I reserve for the honour of presenting to yourself. No other trace of a similar kind could be found. It is most beautiful, though rare. I have delivered papers on the geological structure and formation of the different places to Captain Foster. It is quite unnecessary to say anything more. At Staten Island I observed extensive beds of graphite or black lead.

The collection of shells is good as far as our opportunities permitted, though we found but few. The *Teredo gigas* or *gigantea*, is very abundant at Staten Land, and makes awful destruction upon the timber.

It is with considerable pain I have to speak of birds, having failed completely in that department from want of room and convenience for drying, with a fatality at Shetland of the loss of our collection by a snow storm. In a ten gun brig crammed with ten months' provision and an unusual quantity of stores and instruments, no one can rationally expect much in the way of natural history. There is a total want of accommodation; not a particle of room, especially where the great and sole objects of the voyage are mathematical and philosophical. I have endeavoured to do every thing that was in my power, and have investigated the anatomical structure of seals and penguins, with whom we have been associated for many months. The great peculiarity of structure in this amphibious bird is its great and excessively distended jugular veins being near two inches in diameter. I merely mention this one point respecting the anatomy of the penguin, to associate it with the prodigious and enormous abdominal venour[illegible] the sea leopard or leopardine seal of Jameson,

which you will scarcely credit to be seventeen inches in diameter. That an animal of five or six cwt. and of seven or eight feet in length, should have a venous sinus of seventeen inches diameter, stretching from hypochondrium to hypochondrium, seems incredible;—unparalleled as it is, such is the fact. The skins and heads of five are sent home. There are some minor articles put up in bottles, and the soft parts of the seal which Professor Jameson has erroneously characterized. In respect to the preservation of fish, did room permit me, I intended to have communicated a mode which I have found to answer extremely well in the preserving of them whole without the use of bottles, and so that they are perfect, complete, and entire specimens. I am extremely happy to say we have lost no man since the Chanticleer has been commissioned. I could have communicated much more; but I am afraid I have already tired you with the subject, and have only to solicit the forgiveness of my intrusion. With the most grateful estimation of your kindness, and the best and most sincere wishes of the heart for your happiness, permit me to subscribe myself your most respectful and obliged servant,

W. H. B. Webster.

H. M. S. Chanticleer,
Cape of Good Hope, Table Bay, 27th July 1829.

Art. IV.—*Description of a new Anemometer.* By James D. Forbes, Esq. Communicated by the Author.

Among the various contrivances proposed for the measure of the force or velocity of a current of air, it is surprising how few seem to have had for their object the separation of the exclusive influence of the wind, submissible to rigorous calculation, unincumbered with the effects of friction and the loss of power sustained through accumulated mechanical constructions, before any result which could be subjected to strict calculation was obtained. Of the dynamical methods hitherto employed, that of the equilibration of the aerial current by a column of fluid seems the most unexceptionable, and of those derived from accessory properties, the time of cooling, measur-

ed by a thermometer placed in the stream, is the most philosophical.

But the determination, however precise, of the velocity of the wind at any moment, is of little importance to meteorology; and it is not till we can obtain some general register of the state of the wind in the absence of the observer, by a machine of sufficient simplicity to be generally adopted, that we can hope to raise the philosophy of the wind to that importance which I am disposed to think it deserves to hold in atmospheric science; and no period was ever farther from such an acquisition than the present, when the anemometer is the most neglected of all meteorological instruments. A register of the force or velocity of the wind in the absence of the observer must of course include the register of its direction. An instrument for the last purpose was contrived by one Michael Lomonosow, as I found long after the contrivance I have now to describe was formed; but for the former and more important object, no plan, as far as I know, has been proposed.

The principle of my anemometer occurred to me several years ago, and I sketched the idea of an instrument much in its present form; but having lately added some improvements, and finding, after much occasional consideration, no fundamental defect, nor any notice of a similar contrivance, I have been induced to draw up the following account, and submit the principles to the test of theory.

It is surprising that among the numerous modes of exposing surfaces to the wind and computing its resistance, which have been proposed during this and the last century, * no one seems to have thought the deflection of bodies, exposing a given surface to the current during the time of their fall by the action of gravity through a given height, a suitable means of deducing the deflecting force. I admit that the elevation of an exposed surface constrained to move in the arc of a circle has been employed for such a purpose, and the effect computed by the sine of the elevation; but the principal merit I claim for the new anemometer is the absence of any constraint whatever, and the facilities it gives for direct computation, the weight of the moving body being taken into consideration.

* See the excellent Article ANEMOMETER, in the *Edinburgh Encyclopædia.*

Besides, it has the advantage of self-registration. We shall first consider the theory of the deflection, then the method employed to put it in practice. Briefly then, the principle of the instrument is *to ascertain the measure of the velocity of the passing current, by the deflection from the perpendicular of small bodies mechanically let fall at certain intervals, through a certain space.*

The investigation is similar to that of the simplest case of resistance introductory to the theory of projectiles, for it is the same whether we consider the sphere (for we shall suppose the falling bodies to be spherules) moved through the air by a projectile force equal to the velocity of the wind, or the wind itself rushing upon the sphere in a state of rest with that velocity. In the former case the resistance would be considered as producing an extinction of motion exactly equal to the production of motion in the latter. That is, if A B, Fig. 8 Plate II. represent the velocity of the wind in any moment of time, the body being first exposed to it at A, and the resistance of the current to its state of rest makes it move in the same time through A C, it is the same as if we suppose the air in a state of rest, and the body at A projected with a velocity A *b*, when, the resistance being obviously the same as before, the space moved through will only be A *c*, since *b c* = A C.

It is obvious that the sphere, when exposed to the resistance of the air and the action of gravity united, will describe some curve, as A *a b c*. But we have not, as in the case of projectiles, to compute the resistance on the periphery of the curve, which when at right angles to the wind is wholly inconsiderable, but merely the effort of a constant resistance along the ordinates α *a*, β *b*, &c. The question is therefore resolved into the simple case of resistance in a rectilineal course co-ordinate with that of gravity, identical, in fact, with Lib. ii. Prop. v. of the *Principia*, and of which also a very extended solution has been given by Professor Robison, in the elaborate article *Projectiles* in the *Encyclopædia Britannica*. A very brief exposition of the same problem, borrowed partly from both sources, and applied to the present case, may perhaps be not unacceptable to some readers.

The terminal velocity of a falling body in air is that final limit in which the acceleration of gravity is balanced by the

resistance of the air, of which, therefore, it becomes a measure. Now, for the sake of conciseness, let R be the resistance opposed to a velocity expressed by 1, while r is the resistance to the terminal velocity u. Since the resistance varies with the square of the velocity, $r = R \times u^2$ which is also $= W$, the weight of the body, since it is able to counteract the accelerating force of gravity; hence $u^2 = \frac{W}{R}$ and $u = \sqrt{\frac{W}{R}}$. Now the common theorems of motion give the space through which a body must fall to acquire the velocity u in vacuo $= a = \frac{u^2}{2g}$, where g expresses the usual unit of the force of gravity. But the time corresponding to a is of course by the same theorems $= \frac{u}{g}$, which call e; whence $\frac{a}{e} = \frac{u}{2}$ and $eu = 2a$, which is obviously the space described uniformly with the velocity u in the time e, which is equivalent to the time of the extinction of the acceleration of gravity opposed by the uniform action of the resistance r; for r is assumed $= g$, and e is the time during which a body would ascend, uniformly resisted by gravity. Since r extinguishes the velocity in the time e, R, which is u^2 times smaller, will do it in $u^2 e$, and will extinguish the velocity 1 (being u times less than u) in the time ue, that is, in the time $2a$, and the space described being uniformly resisted, will of course be half of that through which it would have moved with a constant velocity, and will be $= a$; and this result is quite general for any velocity v or V.

To find r, u, or a, is the next object, since any one of these being discovered, the others may be deduced. Newton, by an extended process of investigation in the second book of the *Principia*, has arrived at this theoretical conclusion of the value of r, (which, however mathematicians have doubted the accuracy of the method in this "res difficillima," as Newton himself has called it, the result has been generally acquiesced in;) that the resistance of air to a sphere moving with any velocity is equal to half the weight of a column of air of equal section, and whose altitude is the weight producing the velocity.

Hence let a be the height producing the velocity (in feet), d = diameter of the ball (in inches) $\pi = 3.1416$, &c.; 62.5 lbs. l[illegible]ght of a cubic foot of water, and $\frac{1}{5\,4\,0}$ the

relative density of air; we have r in pounds $= \frac{62.5}{840} \times \frac{\pi}{144 \times 4} \times \frac{a d^2}{2} = \frac{a d^2}{4928\frac{1}{2}}$ lbs. and substituting $\frac{v^2}{2g}$ for a, we have $\frac{v^2 d^2}{315417}$. Whence to obtain a unit of resistance, putting v and d equal to 1 respectively, we have $R' = \frac{1}{315417.}$ And we have by the equation already found $u = \sqrt{\frac{W}{R d^2}}$, since R varies with the square of the diameter of the ball. Hence also $2a = \frac{u^2}{g}$

Let us now endeavour to apply the principles thus obtained to the measurement of velocities and spaces in a medium resisting as the square of the former, since we have already shown, that, by finding the effect of resistance in retarding independent motions, we shall have no difficulty in applying it to the simple effect of resistance upon a body at rest. Since the velocity thus resisted must be in a state of perpetual flux, we must find its relation to the retarding force by some theorem of variable motion. It is this; $\pm d v = f d t$. Now, since the resisting force f is measured by the differential of the velocity v, that differential must be proportional to v^2. Now this is the characteristic of lines drawn from the assymptotes of a rectangular hyperbola to the curve, such as E F, G H, A B, Fig. 1. Plate II. For let the abscissæ D B, D H, &c. be denoted by x, and the corresponding ordinates by y, then, from the property of equality in the rectangular spaces, we have the equation $x y = a^2$; a being a constant quantity. Hence the differential is $x d y + y d x = 0$ and $d y = -\frac{y d x}{x}$. But since $\frac{y}{a^2} = \frac{1}{x}$, $d y = -\frac{y y d x}{a^2}$ in which $d x$ being a constant differential, (for, as we shall presently see, the abscissæ increase uniformly,) and a^2 a constant quantity, $d y$ must vary as y^2, which is property of the velocities resisted as their squares.*

Hence, therefore, if we draw a line A B, which shall represent the initial velocity V, and one at right angles, B D corresponding to the time e, or the time of extinction of the velocity V, when uniformly resisted, the parallelogram thus formed

* See note to *Princip.* ii. 5.; de Motu corporum quibus resistitur in duplicata ratione velocitatum.—Jesuit's Edit.

will represent the quantity $2a$, and having thus obtained a scale for the measurement both of *velocity* and *time*, we may describe the rectangular hyperbola A G E, having C D, D B, forming portions of its assymptotes. The abscissæ D B, D H, &c. will then express the times, (increasing uniformly) and the ordinates B A, G H, &c. the corresponding retarded velocities. Having thus obtained a measure of the times and velocities, the union of them or the areas A G H B, A E F B, &c. represent the spaces described.

But since the hyperbolic areas may be expressed by the natural or Napierian logarithms, from the equality of the rectangles A B C D = I G H D, which is the modulus of the hyperbolic logarithms, or 1, and is here equivalent to $2a$, the difference of the hyperbolic logarithms of any two ordinates will express the area intercepted between them, and its measure will be obtained in terms of $2a$.

But in the case where the velocity is not that of a projectile, but of the impulsive medium, the velocities will not be measured by the ordinates, but by the difference between them and the initial velocity; and the spaces not by the hyperbolic areas, but by the difference betwixt them and a rectangle described by a uniform velocity in the same time. That is, putting S = space moved over, and t = the time of exposure to resistance = B F, A B being as formerly = V, and B D = e, we have

$$S = V t - \left\{ \text{hyp. log. } (e + t) - \text{hyp. log. } e \right\} 2a$$

$$= V t - 2a + \text{hyp. log. } \frac{e+t}{e}.$$ Or for common logarithms substitute $\frac{2a}{M}$ for $2a$, M being the modulus of the common system.

Having thus given a solution of the problem of the extent of deflection occasioned by a current of air under any circumstances, I proceed to describe the instrument which is intended to show its effect. It is represented in Plate II. Fig. 2. From the flat board C D, of which the figure represents a section, rise two iron supports G E and H F, which should be as thin as is consistent with strength in the direction as right angles to the view in t[illegible] Rising from above these in the way there shown, is t[illegible]vind sail A, which must have a cap and vane

not represented in the figure, to shelter one side from the wind and expose the other to its force. On the axis of the sail is the pinion *a*, working into the wheel *b*, which turns the endless screw *c*. By these two transfers of power any required diminution of velocity may be produced. The box B contains a number of spherules to be dropt at short intervals by means of a mechanical contrivance, and in the course of their fall are exposed to the deflecting force of the wind, which deflection is measured by means of the circular rings, *d*, *e*, *f*, *f'*, *e'*, *d'*, in the board C D, of which a horizontal plan is given in Fig. 3, showing by the distribution of the cavities that both the direction and velocity of the wind will be measured at once, being divided into eight, or as many points of the compass as may be desired, and into three or more measures of deflection. It is thus apparent, that, in the estimation of force, the results are wholly independent of any mechanical friction, since all the wheel-work connected with it is merely employed for dropping the balls; which is thus contrived: The bottom of the box B is composed of several parts, a section of which is given in Fig. 4: the centre part Q is the real bottom, and is attached to the sides. It has the thickness of one of the balls, and has a cylindrical perforation *q*, of the same diameter, as represented also in Fig. 5, which is a horizontal section of the same. United by a common axis *g* (Fig. 4,) which passes freely through the centre of the bottom Q, are the two plates P and R, the horizontal surfaces of which are represented at Figs. 6 and 7, and into the edge of the former works the endless screw *c* (Fig. 2,) by which the plates P and R are slowly turned round, being on a common axis, so fixed that while the aperture *r* covers the cylindrical hole in the plate Q, it is closed below by the stop *p* in the plate P, and the reverse, so that it is obvious, that, as soon as the cavity *q* is insulated above, the ball which was received through the opening *r* will drop, which will be repeated once every turn, the recurrence of which may be varied at pleasure by the number of teeth in the wheel-work.

We must, however, observe that the number of pellets dropped into the circular rings in Fig. 3, even should these rings be calculated for spaces corresponding to equal increments of velocity, will not be proportional to the times during which

the wind has blown with each velocity since the last observation; for, unless the dropping of the spherules were performed by clock-work (and I have thought it more fitted for general adoption to employ the force of the wind merely,) the numbers would be proportioned to the revolutions of the sail A, which, without any danger of vitiating the accuracy of the instrument, which throughout it has been my object to construct on principles submissible to rigorous calculation, may be considered *proportional* to the force of the wind, or the square of its velocity; for we have nothing to do with the *absolute* number of rotations occasioned by any given impulsion,—a problem, however, which would meet with constant solutions in the use of the instrument, by comparing the force of the wind computed from the average deflection with the total number of balls fallen during a definite period. The spaces might, however, be so regulated as to indicate the velocities by the number of balls accumulated in them; but this we shall notice presently, giving, in the first place, the application of the theory of deflection to the instrument.

Let us assume the spherules to be one-fifth of an inch in diameter, and that they have the density of water, and that the height they fall through is four feet. Since 0.2 inches $= \frac{1}{60}$ foot, and since a cubic foot of water weighs 62.5 lbs. we have the weight of a spherule $= W = \frac{62.5 \times \frac{\pi}{6}}{60^3} = .0001515$ lb. We have seen that by the Newtonian theory $R = \frac{1}{3151417}$ of a pound, and by the formulæ already explained $u = \sqrt{\frac{W}{R\,d^2}}$ and $2a = \frac{u^2}{g}$. Hence then,

Logarithm R, . .	$\bar{4}.50111$
$d^2 = .04$ inches, log. . .	$\bar{2}.60206$
Resistance to vel. 1. . .	$\bar{3}.10317$
Log. W. . .	6.18041
Diff. $= \log. u^2$ . .	3.07724
$g = 32$ log. . .	1.50515
$2a = 37.33$ feet. log. . .	1.57209

Then, V[illegible]ng the initial velocity, or the velocity of the wind in feet = the extinguishing time $= \frac{2a}{V}$: And if

we suppose V = 40, which corresponds, according to the experiments of Hutton, to a "very brisk wind," $e = 0.''9333$. Since the space fallen through is four feet, t = time of exposure to the wind $= \sqrt{\frac{2s}{g}} = \sqrt{\frac{8}{32}} = 0.''5$; and M = the logarithimic modulus being = 0.43429, &c. we have all the data for solving the equation.

$$S = Vt - \frac{2a}{M} \times \text{Log.}\frac{e+t}{e} = 40 \times 0.5 - \frac{37.33}{0.43429} \times \text{l.}\frac{1.4333}{0.9333}$$

	Log. $2a$	.	1.57209
	— M	.	$\bar{9}$.63778
			1.93431
Log. e =	9.97004		
l. $e+t$ =	0.15635		
l. $\frac{e+t}{e}$	0.18631	2d log.	$\bar{9}$.27023
	16.016 log.		1.20454

Finally; $Vt = 40 \times 0.5 = 20.000$ feet

$$-\frac{2a}{M} \times \text{log.}\frac{e+t}{e} = 16.016$$

Amount of deflection, 3.984 feet.

The case we have just supposed is perhaps one of the most convenient in practice; * it is besides curious, as showing the theoretical effect of wind on falling drops of rain, which are sometimes of the size we have assumed, and the density is equal. As the deflection, however, is greater than would ever be required for accuracy of measurement, the height of the fall, and consequently the time of exposure, might be reduced, which would put the instrument within smaller compass. Suppose the time halved, or = 0.''25, we have $s = 1$ foot, and the last solution is easily altered to the present case.

Log. e =	$\bar{9}$.97004		
$e+t$ = 1.1833 log.	0.07309		
log. $\frac{e+t}{e}$ =	0.10305	2d log.	$\bar{9}$.01805
		log. $\frac{2a}{M}$	1.93431
		8.858 log.	0.94736
$Vt = 40 \times 0.25$ =	10.000 feet.		
Deflection =	1.142 feet.		

* The spherules might be turned out of wood. Perhaps even dry peas might answer the purpose.

A greater space of exposure than in this last case might, however, be desirable, that the wind might have an unrestrained action through the machine.

Suppose, in the first case we have calculated, that the density of the spherules was doubled, it might be easily shown that $2a$ would become $2am$, the density being altered as $1 : m$; and it is also demonstrable that the same change would be produced by altering the diameter in the same ratio. The following computation will serve for the case of density double that of water, and that of a diameter double the last, or 0.4 inches, the velocity being the same.

$2a$ log.	1.57209		
$m = 2$ log.	0.30103		
$2am$	1.87312		
V log.	1.60206		
$e = 1.867$ l.	0.27106	$2am$ log.	1.87312
$t = 0.5$		M log.	$\bar{9}.63778$
$e + t = 2.367$ l.	0.37420		2.23534
$\frac{e+t}{e}$ log.	0.10314	2d log.	$\bar{9}.01343$
		17.732 log.	1.24877
		V t = 20.000	
	Deflection	2.268 feet.	

Supposing, therefore, that spherules of the diameter of 0.2 inches, having a specific gravity of 2, (which might easily be made of some permanent composition approaching this density) be selected as the standard, (or, what is the same, having half the diameter, or 0.1 inch. and a specific gravity of 4,) we may compute for it the spaces corresponding to equal increments of velocity, and if we divide the ordinary velocities of wind into three classes, under 20, under 40, and under 60 feet per second, corresponding to about 14, 27 and 41 miles an hour, we shall have a sufficient illustration for our present purpose. Such a computation once made for any instrument will regulate the breadth of the spaces for the reception of the balls, which, as we have remarked above, would not be in the ratio of the velocities, were they equally divided.

Put. V = 20

2 *a m*	log.	1.87312	
V	log.	1.30103	
$e = 3.733$	log.	0.57209	
$t = 0.5$			
$e + t = 4.233$	log.	0.62665	$\frac{2am}{M}$ l. 2.23534
$\frac{e+t}{e}$	log.	0.05456	2d log. 8.73687
			9.380 log. 0.97221

$Vt = 20 \times 0.5 = 10.000$

Deflection 0.620 feet.

We have already got the deflection when V = 40, 2.268 feet.

Put. V = 60

2 *a m*	log.	1.87312	
V	log.	1.77815	
$e = 1.244$	log.	0.09497	
$t = 0.5$			
$e + t$ 1.744	log.	0.24155	$\frac{2am}{M}$ l. 2.23534
$\frac{e+t}{e}$	log.	0.14658	2d log. $\bar{9}$.16607
			25.200 log. 1.40141

$Vt = 60 \times 0.5 = 30.000$

Deflection 4.800 feet.

We have thus obtained	Ft.	Diff.
V = 20 corresponding Defl.	0.620	
V = 40 ———————	2.268	1.648
V = 60 ———————	4.800	2.532

Of which the second differences are nearly constant.

I have taken occasion to remark, that, although the spaces be thus proportioned to the actual velocities, the number of balls contained in each circular ring will not correspond to the periods during which the wind has blown with the indicated velocity; for the distribution of the spherules depending on the revolutions of a sail, which will be proportional very nearly to the forces, or the squares of the velocities, the numbers in each compartment will of course bear that relation, and, taking the first degree of velocity as a standard, those in the second must be divided by 4, in the third by 9, &c.

It would, however, be quite practicable so to proportion the distances of the rings, as to make the number of balls contain-

ed in each proportional to the times. And for practical purposes, it will be quite sufficient to consider merely the velocities corresponding to the *extreme* deflection included by each space. Let S be the extreme deflection corresponding to the first cavity *f*, (Fig. 2,) and N = the number of balls deposited in any given time. Then obviously $N \propto V^2S$, or it is proportional to the square of the velocity and the space conjunctly. For the other circular rings, for S we must substitute $S' - S$ and $S'' - S'$, &c.; S, S′ and S″ corresponding to the successive extreme deflections. Expanding $N \propto V^2S$, it becomes $N \propto V^2 \times \left(Vt - \frac{2a}{M} \times \log. \frac{e+t}{e}\right)$ and since $e = \frac{2a}{V}$ we have $N \propto V^3t - \frac{2a\,V^2}{M} \times \log. \left(\frac{Vt}{2a} + 1\right)$ which may be thus expressed;

$$N \propto V^3t - \log. \left(\frac{Vt}{2a} + 1\right)^{\frac{2a\,V^2}{M}}$$

a complex expression, but from which might easily enough be extracted the value of V in an approximate manner, and from the object of the inquiry, N, in all values of S is intended to be a constant quantity. In the figures these spaces have been made equal, nor has the proportion of the parts been there particularly attended to. The receptacles for the balls ought also to be made deeper than there represented, to prevent them from starting from their proper places.

I hope I have been sufficiently clear in my descriptions, to show that the instrument in its nature and applications is perfectly elementary, and requires no computation in practice except counting the balls, which by their situation indicate the portion of time since the last observation during which the wind has blown with any force in any direction. And the only adjustment it requires is to collect the pellets from the various spaces, and return them to the box from which they are again to fall.

When an instrument has once been constructed on the principles above laid down, nothing more is required for any period during which it may be used, so long as balls of the same size and density are employed,* and the simple wheel-work kept

* I [illegible]bject of my inquiry, whether small shot might not be ad[illegible]oyed, notwithstanding the great specific gravity of

in order, which may easily be done, by having a water-tight case for that small part of the instrument. Experience will show how far the theoretical principles above laid down are rigorously accurate in practice. The Newtonian result for R has required some modification to coincide with the experimental results derived from projectiles; but it is probable, that where the velocities and spaces are so small as in all cases of the anemometer, it will be found almost mathematically accurate. But, whatever may be the amount of these errors, it is of little consequence in the general principle, as any small empirical coefficient may be employed, which, from accurate experiments in a few particular velocities, may appear requisite.

COLINTON HOUSE, *October* 26, 1829.

ART. V.—*List of the Number of Patents granted for Inventions in England, from the year* 1675 *to* 1829, *inclusive; also a List of Patents in force* 1815-1829.

A Select Committee of the House of Commons was appointed

lead; and, considering their great regularity of surface and perfect equality of size, I am disposed to think that the small quantity of the deflection might be overlooked; for when the velocities are considerable, the deflections found for former cases are in fact too large for convenience, and it probably would not be advisable to reduce the space of exposure below three or four feet. Let us see, therefore, what would be the amount of deflection in the first example given above, the density of the shot being as 11.37 to 1, and the diameter as $\frac{1}{2}$ to 1, or being 1-10th inch. V = 40.

$2a$ log.	1.57209		
5.68	0.75435		
$2adm$	2.32644	$2adm$	2.32644
V log.	1.60206	M log.	9.63778
$e = 5.301$ log.	0.72438		2.68866
$e + t = 5.801$ log.	0.76350		
$\frac{e+t}{e}$ log.	0.03912	2d log.	8.59240
		log.	1.28106
	19.101		
	Vt 20.000		

Deflection, 0.899 ft. or about 11 inches.

last session, to examine evidence on the important subject of "Patents for Inventions," and much valuable information was obtained from the able witnesses examined. The advanced period of the session prevented the Committee from reporting only the minutes of the evidence, but at the same time recommending earnestly to the House to resume the inquiry early next session. We may therefore hope, that the *really* inventive talent of our country will yet be protected from those mercenary and unprincipled invaders, who, without hesitation or mercy, so frequently rob unprotected genius of the honest fruits of its industry and labour.

A comparison of the average grants of patents in the different reigns is not unworthy of investigation. The busy activity of our own times much more than doubles what was regarded as an era of great commercial activity and mechanical invention in the reign of George III. and assumes a very high and lofty character when compared with the reigns of two preceding monarchs of that name. The reign of Anne affords the least numerical average, and the annual increase of patents soon after the accession of William and Mary is not unworthy of attention. The number granted in 1825,—a year so replete with interest in history of speculation and adventurous enterprizes of all kinds, will not be looked at by the philosophic observer of men and things, without the deepest feelings of astonishment and regret.

Charles II.		1686,	3	1698,	8	1710.	
1675,	4	1687,	6	1699,	4	1711,	3
1676,	2	1688,	4	1700,	2	1712,	3
1677,	3	Wm. & Mary.		1701,	1	1713,	2
1678,	5	1689,	1	Anne.		George I.	
1679,	2	1690,	3	1702,		1714,	4
1680,		1691,	20	1703,	1	1715,	3
1681,	5	1692,	24	1704,	4	1716,	8
1682,	7	1693,	19	1705,	1	1717,	6
1683,	7	1694,	9	1706,	4	1718,	6
1684,	12	1695,	8	1707,	3	1719,	2
James II.		1696,	3	1708,	2	1720,	7
1685,	8	1697,	3	1709,	3	1721,	7

1722,	13	1750,	7	1778,	30	1807,	96
1723,	7	1751,	8	1779,	38	1808,	95
1724,	14	1752,	6	1780,	32	1809,	102
1725,	9	1753,	11	1781,	34	1810,	95
1726,	5	1754,	9	1782,	39	1811,	115
George	II.	1755,	12	1783,	64	1812,	119
1727,	7	1756,	3	1784,	46	1813,	143
1728,	12	1757,	9	1785,	60	1814,	94
1729,	8	1758,	14	1786,	59	1815,	99
1730,	11	1759,	10	1787,	54	1816,	118
1731,	9	George	III.	1788,	43	1817,	98
1732,	3	1760,	8	1789,	44	1818,	130
1733,	6	1761,	14	1790,	68	1819,	101
1734,	8	1762,	9	1791,	57	George	IV.
1735,	6	1763,	20	1792,	84	1820,	98
1736,		1764,	14	1793,	43	1821,	108
1737,	3	1765,	14	1794,	55	1822,	113
1738,	6	1766,	30	1795,	50	1823,	138
1739,	3	1767,	23	1796,	73	1824,	181
1740,	4	1768,	23	1797,	54	1825,	249
1741,	8	1769,	36	1798,	77	1826,	131
1742,	6	1770,	30	1799,	82	1827,	148
1743,	7	1771,	22	1800,	96	1828,	152
1744,	17	1772,	30	1801,	104	1829,	37
1745,	4	1773,	29	1802,	105		—
1746,	4	1774,	36	1803,	74	Tot.	5539.
1747,	8	1775,	20	1804,	60		
1748,	11	1776,	29	1805,	95		
1749,	13	1777,	33	1806,	99		

List of Patents in force.

June to Dec.	1815,	53		1824,	181
	1816,	118		1825,	249
	1817,	98		1826,	131
	1818,	130		1827,	148
	1819,	101		1828,	152
	1820,	98	Jan. to May	1829,	37
	1821,	108			—
	1822,	113		Tot.	1855
	1823,	138			

These tables were presented to the Committee by Mr W. H. Wyatt, the editor of the *Repertory of Arts.*

Average annual grant of Patents in the different reigns, adopting the nearest whole number

Charles II.	5	George I.	7
James II.	4	George II.	8
William and Mary.	8	George III.	61
Anne.	2	George IV.	136

We conclude this statement by an account of the number of Patents obtained in England, France, and Austria, as published in the "*Polytechnische Jahrbücher*" at Vienna, and communicated to the Committee by Mr Hawkins.

	England.	France.	Austria.
1821,	106	179	107
1822,	115	135	167
1823,	136	153	197
1824,	180	164	236
1825,	247	246	194
1826,	130	214	198
In six years,	914	1091	1099
Yearly average.	152	182	183

Average in England from 1818 to 1826, 138

PLYMOUTH, *October* 21, 1829.

ART. VI.—*On a new series of periodical colours produced by the grooved surfaces of metallic and transparent bodies.* By DAVID BREWSTER, LL. D. F. R. S. L. and E. *

IN the year 1822, when I received from Mr Barton some very fine specimens of his Iris ornaments, I availed myself of the opportunity of performing a series of experiments on the action

* Read before the Royal Society of London, May 21, 1829, and slightly abridged from the *Phil. Trans.* 1829, p. 301—316.

of grooved surfaces upon light. As the subject was to a certain extent new, many of the results which I obtained seemed to possess considerable interest, and I accordingly communicated to the Royal Society of Edinburgh a general account of them, which was read on the 3d of February 1823. The interruptions, however, of professional pursuits prevented me, but at distant intervals, from pursuing the inquiry; and having found that M. Fraunhofer was actively engaged in the very same research, with all the advantages of the finest apparatus and materials, I abandoned the subject, though with some reluctance, to his superior powers and means of investigation. During a visit paid to Edinburgh by the Chevalier Yelin, a friend of Fraunhofer's, and a distinguished member of the Academy of Sciences of Munich, I showed him the general results which I had obtained; and as he assured me that the phenomena which had principally occupied my attention had entirely escaped the notice of his friend *, I was thus induced to resume my labours, the results of which, in relation to one branch of the subject, I shall now submit to the consideration of the Society.

When a flat and polished metallic surface is covered with equal and equi-distant grooves, we may characterize it by the relation of two quantities, one of which m, represents the breadth of each groove, or of the surface that is removed, while the other n, represents the breadth of the intermediate space, or of the original surface that is left. If the image of a candle is seen by reflexion from such a surface, the trace of the plane of reflexion being parallel to the grooves, we observe the colourless image of a candle in the middle of a row of prismatic images arranged in a line perpendicular to the grooves. The colourless image of the candle is formed by the original portions n of the metallic surface, while the prismatic images are formed by the sides of the grooves m. This may be demonstrated ocularly by increasing m, and consequently diminishing n till the latter nearly disappears. In this case, the intensity of the prismatic images rises to a maximum, while the ordinary co-

* The memoir of M. Fraunhofer was read to the Bavarian Academy of Sciences on the 14th of June 1823; and has no relation to the subject of this paper.

lourless image becomes extremely faint, and *vice versâ*. The general phenomena of the prismatic images, such as their distance from the common image, and the dispersion of their colours, depend entirely on the magnitude of $m + n$, or the number of grooves and intervals that occupy any given space; and the laws of these phenomena have been accurately determined by M. Fraunhofer.

In the course of my examination of the prismatic images, I observed in some specimens an unaccountable defalcation of particular colours, varying with the angle of incidence, and sometimes affecting one of the images and not the others. It sometimes appeared in close and sometimes in wide systems of grooves, and from the symmetry of its effects, it became obvious that it was not owing to any accidental cause. In the specimen in which it was most distinctly seen, I was surprised to observe that the white image reflected from the original surface of the steel was itself slightly coloured; that its tint varied with the angle of incidence, and had some relation to the defalcation of colour in the prismatic images.

Hitherto I had used a small disc of light, but in order to observe through a great range of incidence I employed a long narrow rectangular aperture, which gave a convergent beam of 30° or 40°. I thus saw a series of very interesting phenomena. The ordinary image of the aperture, as formed by the spaces n, was crossed in a direction perpendicular to its length, with broad coloured fringes varying in their tints from 90° to 0° of incidence. This remarkable effect I observed in various specimens, having from 500 to 10,000 grooves in an inch. In a specimen with 1000 grooves in an inch, or in which $m + n =$ 1000dth of an inch, no less than four complete orders of colours were developed, as shown in the following Table:—

	° ′		° ′
White - -	90 00	Brilliant blue.	74 30
Yellow - -	80½	Whitish -	71
Reddish orange	77½	Yellow -	64 45
Pink - -	76 20	Pink - -	59 45
Junction of pink and blue -	75 40	Junction of pink and blue - -	58 10

	° ′		° ′
Blue - -	56	Pinkish yellow.	41
Bluish green -	54 30	Pink red -	36
Yellowish green	53 15	Whitish pink	31
Whitish green	51	Green -	24
Whitish yellow	49	Yellow -	10
Yellow -	47 15	Reddish -	0

These colours are obviously those of the reflected rings in thin plates. By turning the steel plate round in azimuth, the very same colours are seen at the same angles of incidence, and they suffer no change either by varying the distance of the luminous aperture, or the distance of the eye of the observer.

I now examined various other specimens which possessed the same property. In some there were three orders of colours, in others two, and others one, while in some only one or two tints of the first order were developed. These different effects are more minutely detailed in the following Table.

No. of grooves in an inch.	Orders and portions of orders of colours developed from 90° up to 0° of incidence.
500	Citron yellow of the first order.
625	One complete order, and up to reddish yellow of the second order. Colours very dilute.
1000	Four complete orders of colours.
1000	One complete order, together with blue green and yellowish green of the second order.
1250	One complete order, together with blue and bluish green of the second order. Colours exceedingly faint and diluted.
2000	One complete order, together with blue green and greenish yellow of the second order.
2000 on wax.	One complete order, together with greenish yellow of the second order.
2000 ———	One complete order, together with gamboge yellow of the second order
2500 ———	One complete order, together with the full blue of the second order.
3333 ———	Gamboge yellow of the first order.

No. of grooves in an inch.	Orders and portions of orders of colours developed from 90° up to 0° of incidence.
5000 on wax	One complete order, together with bluish white of the second order. Colours more dilute than in No. 5.
10000 ———	One complete order, together with blue and fainter blue of the second order.

It is obvious from the preceding table that the diversity of effect produced by different specimens does not depend upon the quantity $m + n$, but upon n. The more that the original surface is ploughed away by the cutting diamond, the more brilliant were the tints, and the more numerous the orders of colours.

I was now desirous of seeing what effect would be produced when the original surface was almost wholly removed; and Mr Barton was so obliging as to execute for me a specimen containing 2000 grooves in an inch, in which this was nearly effected. His diamond point, however, having unfortunately broken before he had executed any considerable space, I was unable to make all the experiments with it which I could have wished.

This specimen produced four complete orders of colours, all of which were developed at much greater angles of incidence than those in the preceding Tables.

	° ′		° ′
White - -	90 00	Green.	
Straw yellow.		Yellowish green.	
Faint red.		Yellow.	
Pink.		Orange.	
First limit of pink and		Scarlet.	
blue -	80 00	Purple.	
Blue.		Third limit of pink and	
Green.		blue	48 00
Yellow.		Blue.	
Red.		Brilliant green.	
Pink.		Yellowish green.	
Second limit of pink and		Yellow.	
blue -	69 40	Reddish - -	10 00
Blue.			

Such being the phenomena exhibited by the ordinary image formed by reflexion from the original spaces *n*, I now proceeded to examine the prismatic images in the first specimen with 1000 grooves, and I observed the following appearances.

Let A B, Fig. 9, Plate II. be the reflected image of the rectangular aperture from the spaces *n*, and *a b*, *a′ b′*, *a″ b″*, *a‴ b‴*, the prismatic images of it, *v v*, *v′ v′*, &c. being the violet sides, and *r r*, *r′ r′*, &c. the red sides of these spectra. Then in the

1st spectrum *a b*, the violet rays are obliterated at *m* at an incidence of 74°, and the red rays at *n* at an incidence of 66°, the intermediate colours, blue green, being obliterated at intermediate points between *m* and *n*, and at angles of incidence intermediate between 74° and 66°. In the

2d spectrum *a′ b′*, the violet rays are obliterated at *m′* at an incidence of 66° 20′, and the red at *n* at 55° 45′. In the

3d spectrum *a″ b″*, the violet rays are obliterated at *m″* at 57°, and the red at *n″* at 41° 35′. And in the

4th spectrum *a‴ b‴*, the violet rays are obliterated at *m‴* at 48°, and the red rays at *n‴* at 23° 30′.

Another similar succession of obliterated tints takes place on all the prismatic images at a lesser incidence, as shown at *μ ν μ′ ν′* the violet being obliterated at *μ*, and the red at *ν*, and the intermediate colours at intermediate points. In this second succession the line *μ ν* begins and ends at the same angle of incidence, as the line *m″ n″* in the third prismatic image *a″ b′*; and the line *μ′ ν′* on the second prismatic image corresponds with *m‴ n‴* on the fourth prismatic image.

This singular obliteration of the colours is shown more clearly in Fig. 10, where *r m v n* is a part of one of the prismatic images, *r v* the red space, *g g* the green space, *b b* the blue, and *v v* the violet space. The line of obliteration *m n* in beginning at *m* obliterates the extreme violet at *m*; so that the curve of illumination *a b m*, Fig. 11, is just affected at one extremity *m*. The line advances into the spectrum, and at the point corresponding to *d*, Fig. 10, a portion of the blue and violet is obliterated, as shown by the notch in the curve; at *e* a portion of the green and blue; at *h* a portion of the red and green, and at *n* the extreme red.

A similar obliteration of tints takes place on the ordinary image A B.

The 1st obliteration, viz. that of the violet, takes place at *o*, Fig. 9, and that of the red at *p*; while the intermediate colours disappear at intermediate points. This first space of obliteration has no corresponding one at the same incidence in any of the prismatic images.

The 2d obliteration of the violet in A B takes place at *q*, and that of the red at *r*, and this corresponds in incidence with the obliterations *m' n'*, *m' n'* on the second prismatic image.

The 3d obliteration of the violet takes place at *s*, and that of the red at *t*, and this corresponds in incidence with the four obliterations on the second and fourth prismatic images, viz. *μ ν μ' ν' m''' n'''*, *m''' n'''*.

In all these phenomena the points *m*, *n*, *μ*, *ν*, &c. are only the points of minimum intensity, or of maximum obliteration; for the tints never entirely disappear, and those obliterated at each line *m n* form an oblique spectrum containing all the prismatic colours.

The analysis of these curious and apparently complicated phenomena becomes very simple when they are examined under homogeneous illumination. The effect produced in red light is represented in Fig. 12, where A B is the image of the rectangular aperture reflected from the faces *n* of the steel, and the four images on each side of it correspond with the prismatic images. All these nine images, however, consist of homogeneous red light, which is obliterated at the fifteen shaded rectangles, which are the minima of the new series of periodical colours which cross both the ordinary and the prismatic images. The centres *p*, *r*, *t*, *n*, *ν*, &c. of these rectangles correspond with the points marked with the same letters in Fig. 9, and if we had drawn the same figure for violet light, the centres of the rectangles would have corresponded with *o*, *q*, *s*, *m*, *μ*, &c. in Fig. 9. The rectangles should have been shaded off to represent the phenomena accurately, but the only object of the figure is to show to the eye the position and relations of the minima of the periods.

If it should be practicable to remove a still greater portion of the faces *n* the first minimum *p*, Fig. 12, would commence

at a greater angle of incidence; and other two rows of minima, namely, rows of five and six, would be found extending to the fifth and sixth prismatic images. The arrangement and succession of these is easily deducible from Fig. 11, where the law of the phenomenon is obvious to the eye.

The following table contains the angles of incidence reckoned from the perpendicular at which these minima occur in the extreme rays.

Position of the minima in red light.

	Ord. Im.	1. Pris. Im.	2. Pris. Im.	3. Pris. Im.	4. Pris. Im.
	′	° ′	° ′	° ′	′
First minima, *p*,	76 0	66 0	55 45	41 35	23 30
Second minima *r*,	55 45	41 35	23 30		
Third minima,	23 30				

Position of the minima in violet light.

First minima,	81 30	74	66 20	57	48
Second minima,	66 20	57	48		
Third minima,	48				

When the steel with 1000 grooves is exposed to common light, and the incident ray is very near the perpendicular, the 5th, 6th, 7th, and 8th prismatic images are combined into a mass of whitish light terminated externally by a black space. As the angle of incidence increases, the 6th, 7th, 8th, and 9th images are combined into this mass, then the 7th, 8th, 9th, and 10th images, and so on, the black space which terminates this mass receding from the axis or image A B, Fig. 10, as the obliquity of the incident ray increases.

Having covered the steel plate with water and oil of cassia in succession, I found the angular distances of the black space to be as follows at the same incidence.

	° ′
Air, - - -	12 23
Water, - - -	17 15
Oil of cassia, - -	21 22

The sines of which are inversely as the indices of refraction of the fluids.

Phenomena analogous to those above described take place on the grooved surfaces of gold, silver, and calcareous spar, &c.

In order to study this subject under a more general aspect, I was desirous of examining the phenomena exhibited by grooved surfaces of different refractive powers. It was obviously impossible to procure systems of lines upon transparent bodies in which the grooves should have exactly the same distance and magnitude; but I conceived it practicable to impress upon different substances the very grooves which produced the preceding phenomena, and I succeeded in impressing the system of 1000 grooves upon tin, realgar, and isinglass.

The following results were obtained with Tin, the colours being those upon A B, Fig. 10.

White - -	90 0	2d junction of pink and	
Yellow.		blue - -	57 40
Pink.		Bluish green.	
1st junction of pink and		Yellow.	
blue - -	76 20	Orange.	
Greenish blue.		Pink.	
Yellow.		3d junction of pink and blue.	
Pink.			

First minimum of red	76
Second ———	61

The following results were obtained with Realgar.

White - -	90 0	Yellow - -	63
Yellow - -	80	Bright pink -	54
ink - -	75 30	2d junction of pink	
1st junction of pink		and blue -	47
and blue -	73 10	Bluish green -	41
Blue - -	72	Yellow - -	36
Bluish green -	70 15	Pink - -	32
More and more pink.			

First minimum of red	72 0
Second ———	61 15

The following results were obtained with Isinglass. The colours were generally the same as in the steel.

The first limit of pink and blue was at	75 45
The blue of second order - - -	73 45
The [illegible]t of pink and blue was at	54 30

In these experiments the tin gave nearly the same results as the steel; but in the realgar and the isinglass, similar tints were produced at a less angle of incidence than in the steel. The minima of the periods were exhibited very finely on the isinglass, and were produced at similar angles of incidence.

In a specimen with 1000 grooves upon isinglass, the third pink, or that seen upon steel at 36°, was the highest; but after drying, the pink descended to yellow, and subsequently to green.

If the isinglass is removed from the steel when it is still soft, the edges of the grooves get rounded and lose their sharpness, and only one prismatic image is seen on each side of the ordinary image, as in mother-of-pearl.

The mass of white light is finely seen in the impressions taken upon tin, but never appears upon isinglass.

The preceding experiments do not afford any precise data for determining the influences of refractive power. The realgar and the isinglass give fewer periods of colour so as to indicate that, *cæteris paribus*, a diminution of refractive power produces a diminution in the number and orders of colours, or causes the minima to be developed at a less incidence. This indication, however, is opposed by the fact, that, as the isinglass dries, and consequently increases in refractive power, the periods diminish in number, and the minima are produced at less incidences. The modification of the tints by a change of refractive power is here masked by the influence of other causes, namely, an inferiority in the sharpness of the impression to that of the original surface, and a rounding of the narrow spaces n subsequently produced by induration. In the specimen of isinglass, therefore, already mentioned, which gave the first limit of pink and blue at nearly the same angle as the steel, it is probable that it would have developed the same limit at a greater inclination had the impression been as sharp as the original.

In this uncertainty I conceived that the influence of a variable refractive power would be best obtained by placing different fluids on the surface of the grooved steel; and upon using alcohol and oil of cassia my expectations were fulfilled.

The following were the results:—

No. of grooves in inch.	Maximum tint without a fluid.	Maximum tint, with water, alcohol, and oil of cassia.
312	No colour,	1. Water. Tinge of Yellow. 2. Alcohol. Tinge of Yellow. 3. Oil of cassia. Faint reddish yellow.
500	Citron yellow of first order,	1. Water. Tinge of red. 2. Alcohol. Diluted pink. 3. Oil of cassia. A bluer pink.
625	Reddish yellow, of second order,	1. Water. Faint pink of second order. 2. Alcohol. Ditto more pink. 3. Oil of cassia. Bluish pink, of second order.
1000	Yellowish green of second order,	1. Water. Pinkish red, second order. 2. Alcohol. Brilliant pink, ditto. 3. Oil of cassia. Greenish blue, third order.
1250	Bluish green faint,	1. Water. Yellow of second order. 2. Alcohol. Yellower. 3. Oil of cassia. Yellowish pink.
2000	Greenish yellow of second order.	1. Water. Brownish red, second order. 2. Alcohol. Pinkish red, ditto. 3. Oil of cassia. Greenish blue.
2500	Blue, second order,	1. Water. Dilute green. 2. Alcohol. Greenish white, second order. 3. Oil of cassia. Bright gamboge yellow.
3333	Gamboge yellow of first order,	1. Water. Pinkish red, first order. 2. Alcohol. Reddish pink. 3. Oil of cassia. Bright blue, second order.
5000	Bluish white of second order,	1. Water. Pale yellow. 2. Alcohol. Yellow with tinge of orange. 3. Oil of cassia. Yellowish pink, second order.
10000	Fine blue of second order,	1. Water. Greenish white of second order. 2. Alcohol. Yellowish white. 3. Oil of cassia. Brilliant gamboge yellow.

I obtained similar results with grooves impressed upon wax; so that we may now safely draw the conclusion that more orders of colours, and consequently higher tints at a given incidence, are developed by diminishing the refractive power of the grooved surface.

The influence of refractive power on the tints of the ordinary image being thus determined, it became interesting to ascertain its effects on the obliterated tints of the prismatic images. As these tints never appeared unless when that of the ordinary image exceeded the blue of the second order, I took the specimen with 10,000 grooves, which had for its maximum tint a blue of the second order, but which exhibited no obliterated tints in the prismatic images. Having placed upon

it a film of oil of cassia, I raised the blue to a gamboge yellow, and I found that the fluid developed the phenomena of obliterated tints on the first prismatic image. Owing to the great breadth of the spectrum, the distinct separation of the colours which composed it, and the great length of the line of obliteration, this phenomenon was one of the most beautiful and remarkable that I have ever witnessed.

Hitherto I had examined the minima in the prismatic images as symmetrically related in position to the minima in the ordinary image, as shown in Figs. 10 and 11 ; but in studying some specimens in which the spaces n were very broad, and the grooves or spaces m comparatively narrow, I was surprised to observe obliterated tints on the prismatic images, while the ordinary image was entirely free of colour. This took place in two specimens, one of which had 312, and the other 625 grooves in an inch. The spaces n were here far too wide to produce the new tints, and so were the spaces m; but upon applying the microscope to the grooves m, I saw that they were formed by two or more grooves ploughed out by the cutting point ; so that each space m actually consisted of smaller reflecting spaces, which were sufficiently minute to produce the periodical colours.

Although in these specimens, therefore, when m is nearly equal to n, we observe a beautiful coincidence between the positions of the minima on the ordinary and on the prismatic images, yet the fact above described seems to show that they are separate phenomena, and depend, when the grooves are single, on the relation between m and n.

The preceding observations relate solely to rays reflected from grooved surfaces; but in consequence of the almost perfect transparency of isinglass in thin plates, I have been enabled to examine the transmitted tints. The colours which are thus seen on the ordinary image are extremely brilliant, but they seem to have no relation whatever, either in number or in quality, to the reflected tints. In the specimen which gave by reflection three orders of colours, those seen by transmission were only the following,

Fine blue	- -	85° of incidence.
Purple.		
Red.		
Orange.		
Yellow	- -	0 vertical incidence.

Another specimen from the same steel plate gave, when soft and newly taken off, a bright purple at a perpendicular incidence, which passed through pink and blue at greater incidences. But in the process of induration, the vertical purple became red, orange, and yellow. In a third impression the perpendicular tint was a bright pink when soft, which descended to yellow when drier.

In order to observe the relation between the reflected and transmitted tints, I took a fresh impression on very transparent isinglass, and obtained the following results:

Reflected tints.	Transmitted tints.	Angles of incidence.
Yellow - - -	Deep blue	- 90
Orange - - -	Paler blue.	
Pink - - -	Blue.	
First limit of pink and blue	Blue.	
Blue - - -	Pink.	
Green - - -	Orange pink.	
Yellow - - -	Orange.	
Orange - - -	Yellow.	
Pink - - -	Yellow.	
Second limit of pink and blue	Yellow.	
Blue - - -	Yellow	- 0

The comparison of these tints affords the most satisfactory evidence that they are not complementary to each other. The transmitted tints of the ordinary prismatic images always increase in brightness as the angle of incidence diminishes, while the reflected tints become fainter.

As I had preserved the different specimens of isinglass with which these experiments were made, it became interesting to observe the changes which their colours had undergone after a lapse of six years. The following was the result:—

1. A specimen with 1000 grooves exhibited no colours on the ordinary image either by reflection or transmission. The prismatic images of a candle were very faint, and the fourth could scarcely be seen.

2. Another specimen of 1000 grooves gave by reflection one period of colours from white at great incidences through yellow up to purple at a vertical incidence. By transmission a little yellow only was seen at a great incidence.

3. A third specimen of 1000 grooves, which had been a fine sharp impression, gave by reflection two orders of colours, the first limit of pink and blue being at 57° 45′, and the second limit nearly at a vertical incidence, a deep pink appearing at 10°. By transmission the isinglass gave a bluish-green at the greatest incidence which passed at lesser incidences through purple to yellow, which was the maximum tint.

In all these specimens the colours remain the same in all azimuths, provided the angle of incidence is invariable.

As the steel plate from which all these impressions had been taken was much injured, I resolved to grind down its surface by a polishing powder, and to observe the changes which took place. As the effect of this was to increase the spaces n, the colours on the ordinary image soon disappeared. The phenomenon of the obliterated tints was no longer seen, the mass of white light disappeared, and from the rounding of the edges of the grooves the prismatic images were fewer in number, though their distance was unchanged.

Such are the leading phenomena of this new and remarkable class of periodical colours; but though their general law and the circumstances upon which they depend seem to be pretty clearly shown in the preceding experiments, yet I feel great difficulty in assigning a satisfactory cause for their production. That they are not owing to the diffraction and interference of the rays reflected from two or more of the surfaces n, considered as narrow slits or apertures, is obvious; for in that case they would be affected by the distance of the luminous object and the distance of the eye, and the colours would form bands parallel to the direction of the grooves.

In my experiments on the production of the complementary colours by the metallic reflection of polarized light, I have

shown that one reflection from a plate of silver, &c. is equivalent in its action to a given thickness of a crystallized film, and that the tints descend in the scale by increasing the angle of incidence as if the equivalent film had diminished in thickness. That these colours are produced by the interference of two pencils, one of which suffers reflection later than the other, cannot be doubted; but whether these two portions are reflected within the sphere of reflecting activity, at such distances as to produce colours by their interference, or whether the one is reflected in the usual manner, while the other is not reflected till it has penetrated a certain thickness of the polished metal, it is not easy to ascertain.

If either of these effects takes place with polarized light, an analogous effect should be produced with common light, though the intensity of the interfering pencils might in this case be very inconsiderable.

If we suppose that the spaces n are smaller than the distance to which the reflecting force extends, the removal of the metal from the adjacent grooves must diminish the reflecting force of these spaces. That this is the case may, we think, be inferred from direct experiment. At the separating surface of the steel and a fluid, we observe a certain change in the action of the steel surface, which can be ascribed to no other cause than the diminution of the refractive and reflective power of the surface. Now it is manifest from experiment that the diminution of the spaces n has exactly the same effect, the colours not only being rendered brighter by each of these causes, but the minima being produced at greater angles of incidence.

Since in a system of grooves with only 312 in an inch, oil of cassia developes colours which did not previously exist, it is evident, that, if we had fluids of much higher refractive power, colours would be produced when the spaces n were much larger, and when the fluid approached in refractive density to that of the metal, we should witness the periodical colours without any grooves at all on the reflecting surface; so that the phenomena would then become identical with those which are developed at the separating surface of transparent bodies.

We can scarcely, therefore, avoid the conclusion, that the removal of the substance from the grooves, whether they are

made on metal or on transparent bodies, diminishes the refractive power of the intermediate spaces. On the hypothesis of emission, this abstraction of the reflecting matter may be regarded as equivalent to a diminution of the density of the surface; while on the undulatory hypothesis, the effect may be ascribed to the condition of the ether arising from a variation in its density or elasticity towards the extremities of a number of salient points.

ART. VII.—*On the Mullets of Europe.* By Baron CUVIER.*

THE fishes named τρίγλη by the Greeks and *Mullus* by the Romans, are without contradiction those which have been most celebrated in the writings of the ancients for their excellence as food and for the beauty of their colours; and it was with regard to these fishes that Roman luxury occupied itself with the greatest solicitude.

The name *Triglia*, which is applied to the mullet in many parts of Italy, is not the only reason for supposing that the mullet was the τρίγλη of the Greeks. Pliny translates this term by *Mullus*, quoting a passage from Aristotle, where it is said that the *Trigla* spawns thrice in the year. The *mullus* of the Romans may be safely regarded as the *rouget-barbet* of the French (*Mullus barbatus*, Lin.); for Pliny characterizes it distinctly by the double beard or cirri of the under jaw, and by its red colour. This beard is also mentioned in two places by Athenæus.

The name τρίγλη has been derived from the triple spawning attributed to these fishes, and this name in its turn occasioned the species to be dedicated to the triple Hecate or to Diana, surnamed τρίγληνος, (triple-eyed); from whence, by another of the inductions too habitual with the Greeks, the Trigla have acquired the reputation of being anti-aphrodisiac.

The name *Mullus* has, however, been referred to another origin. It is derived, say some, from the colour of the fish resembling that of the sandals worn by the Alban kings, called

* From *l'Histoire Naturelle des Poissons*, par Baron Cuvier et M. Valenciennes, vol. iii. Paris, 1829.

mulleus, and which having continued under the republic to be worn by the consuls, were transmitted downwards as part of the imperial dress.

Though the Greeks boasted of the excellence of their Trigla, yet in the Roman writers the mullet is oftener mentioned, and in more expressive terms. Among the Romans extravagant prices were paid for this fish; it was brought to market from a great distance, and no expence was spared to procure it. The value of Mullets was estimated by their weight, and 2lbs. being, according to Pliny, the greatest weight generally attained by this fish, it was considered when of this size as a magnificent dish, although the Roman pound was a third less than that of France. Martial mentions the purchase of a mullet of this weight among the sacrifices which his mistress exacted from him; and, in speaking of a sumptuous entertainment which he declined, he says

Nolo mihi ponas rhombum, mullumve bilibrem.

A mullet of 3 lbs. weight was regarded as an object of admiration; and the same author represents one of 4 lbs. as an absolutely ruinous dish.

Addixti servum nummis here mille trecentis,
Ut bene cœnares, Calliodore, semel:
Nec bene cœnasti. Mullus tibi quatuor emptus
Librarum, cœnæ pompa caputque fuit.
Exclamare libet, non est hic improbe, non est
Piscis: homo est: hominem, Calliodore, voras.*

Seneca relates the history of a mullet presented to Tiberius which weighed four pounds and a half, and that this prince, ridiculously economical, sent it to the public market. Juvenal mentions one which was sold for 6000 sesterces (about

* Mart. l. x. ep. 31. On this passage Cuvier has the following curious note: "Bloch, who did not understand Latin, fancied that Calliodorus had bought four mullets; and a writer who knew this language well, (Lacepede) in place of consulting the original, not only chose to copy this fine explanation, but also, from an equivocal phrase of Bloch, he has attributed these verses to Juvenal; and, after I know not whom, has supposed that Calliodorus had paid for his four mullets 400 sesterces, while one only cost him 1300 sesterces."—We have looked into some of the reprints of Lacepede, and writers who have borrowed his statements, and find these errors continued with faithful adherence to the original mistake.

L. 48 Sterling), and which weighed nearly 6 lbs. Asinius Celer, as Pliny relates, bought one for 8000 sesterces (about L. 64 Sterling) in the time of Caligula. But the dearest of all are those of which Suetonius speaks, which, three in number, brought 30,000 sesterces (about L. 243 Sterling): which circumstance induced Tiberius to enact sumptuary laws, and to tax provisions brought to public market. Cuvier conjectures that three individuals of large size being offered for sale at once had thus enhanced the price.

These large mullets came from the sea, and perhaps from distant fishing-grounds. Though the Romans kept mullets in their fish-ponds, and even tamed them so as to come at their master's call, Pliny says they did not thrive. Their domestication was attended with extraordinary expence, for this fish supports confinement with difficulty, and scarcely one, says Columella, survives of many thousands.

It would be difficult to explain why Hortensius, as related by Varro, took so much trouble to preserve in his ponds fishes which the neighbouring seas afforded in such abundance, were it not known that one of the refinements of Roman luxury was, to have them in artificial rivulets under their tables, and to see them die in vases of glass, that they might observe the changes which the brilliant colours of the mullet underwent in its dying agonies. Cicero, in one of his letters to Atticus, sadly deplores this puerile taste of the wealthy Romans; and Seneca makes long declamations against it, at a period when this amusement might have seemed innocent, as compared with the other aberrations of a people surfeited with enjoyment.

It may be interesting to the general reader to quote one of the passages which Cuvier gives from Seneca, as illustrative of the feelings with which the rich Romans surveyed the changing colours of the dying mullet. "Nothing is finer, it is said, than an expiring mullet. The efforts which it makes against death spread over all its body the most brilliant red, which afterwards terminates in a general paleness; but in this passage from life to death, how many shades of these two colours are intermingled!—It has been said formerly, that nothing is better than a mullet taken among rocks. To-day they say nothing is finer than an expiring mullet.—Hand me this vase

of glass that I may see it bound, that I may see it leap! After having for a long time praised it with extasy, it is taken from the transparent vessel. Then the most expert instruct others. See this fiery red, brighter than the finest vermilion! look at these inflated veins! its belly may be compared to blood! Have you remarked the azure lustre which its gills reflect!" &c.

But it was not solely for the pleasure of seeing the varying colours of the expiring mullet that the Roman epicures thus treated it. The pleasure of eating it in the freshest possible state was another inducement. "The fish is already rancid," Seneca represents one of these rich gourmands saying, "were it caught even this very day."—"But it it has been fished this instant," was the answer. The reply follows, "I will not trust you in an affair of so much importance; I will believe nothing but my own eyes.—Let them bring me the fish, that it may die before me." This precaution, according to Cuvier, was necessary, since Apicius had taught that the mullet should die in the *garum* of its associates, and a sauce be made of its own liver. Galen says, indeed, that the liver of the mullet was accounted the most delicious morsel, and that it was pounded in wine for a seasoning to the fish, but that this sauce was not much to his taste.

In after periods this passion for mullets had much diminished, for Macrobius assures us that in his time they were often seen above 2 lbs. weight, but that the excessive prices of former ages were unknown. At present mullets, without being the object of cares so extraordinary, or prices so exorbitant, are yet with reason accounted among the best fishes of the sea. Those of Provence, and chiefly those of Toulon, are particularly celebrated. Their flesh is white, firm, friable, agreeable to the taste, and is digested easily, because it is not fat.

Our seas, says Cuvier, produce two species of these fishes, which Salviani first distinguished and figured. The smallest of these, with the snout more vertical, and of a deeper purple red than the other (*Mullus barbatus*, Lin.) is most abundant in the Mediterranean, and the only one which Belon and Rondeletius has represented. The other (*Mullus surmuletus*, Lin.) is larger, with the snout more oblique, and the red interrupted longitudinal yellow lines. It is much more com-

mon than the other on particular coasts, but it also inhabits the Mediterranean; and it is probable that to this species may be referred the mullets of 2lbs. weight of which the Romans made so much account. Pliny says expressly that these large mullets were found chiefly in the northern and western ocean. The smaller species is the most esteemed, as it is also the most beautiful from the lustre of its colours. This was without doubt the species which was kept in the fish-ponds of the Romans, and which was brought living under their tables,—in short, the *Mullus barbatus* to which Cicero alludes.

The Surmullet, or *Mullus surmuletus* of Linnæus, is brought to market at Paris in the months of April and May. On the coast of La Mancha it is not rare. Pennant says that it appears also in the month of May upon the Devonshire coast, and that it is found till November. Ray mentions that an individual of this species had been taken at Penzance in Cornwall. In proportion as we retire to the North the species becomes more rare. It is as such that it is cited among the fishes of the Baltic and Northern Sea in Schonevelde's *Ichthyology of Holstein*, and in the *Fauna Succica*. Approaching the South of Europe, on the contrary, the surmullet becomes more plentiful. It is much used at Bordeaux and Bayonne, where it is named *barbeau* and *barberin*. Cornide mentions it among the fishes of Galicia under the names of *barbo* and *salmonete*. In many places of the Mediterranean it is more common than the other species, particularly upon the coasts of Sardinia. It abounds in the lagunes of Venice, where it is called *tria*; it it is denominated *streglia* at Nice; Brunnich has described it at Marseilles under the name of *rouget*; and it is probable that Forskal, when he assures us that the *Mullus barbatus* is common and despised at Constantinople, speaks only of the *M. surmuletus*. Its flesh is, according to Cetti, held in less esteem than that of the *M. barbatus*, so celebrated on the coasts of Provence; but the Parisians notwithstanding know well how to appreciate it. The general length of the surmullet is about a foot, but they are found from 14 to 15 inches long.

The true Mullet, or *Mullus barbatus*, Lin. is at once distinguished from the former by the form of its head, which

slopes more vertically; by its more uniform and deeper red colour, with the most beautiful iridescent reflections; and from its being destitute of the yellow stripes. The under part of the body is silvery, and the fins yellow. It is found in the Mediterranean on all its shores, but principally where there is a muddy bottom, and abounds on the coasts of Provence. Several varieties of this fish, as well as the surmullet, have been mentioned by authors; but whether these are to be considered as different species, or as varieties in appearance produced by age, sex, or season, is not yet ascertained.

ART. VIII. *Account of the new genus Melanorrhœa, or the Burmese Varnish Tree, with remarks on each of the Genera to which it approaches**. By N. Wallich, M. D., F. R. S. Ed. F. L. S. &c. Superintendant of the Botanic Garden Calcutta. Communicated by the Author.

MELANORRHŒA.

Sepale 5 in calycem calyptraceum, 5-nervium, caducum, valvatim cohærentia. PETALA 5, raro 6, æstivatione imbricantia, persistentia, infra fructum aucta. STAMINA plura, distincta, toro convexo inserta. PISTILLUM 1. OVARIUM obliquè lenticulare, stipitatum, 1-loculare, 1-sporum: ovulo suspenso cordâ funiculari liberâ, e fundo loculi adscendente. STYLUS lateralis verticis ovarii. STIGMA parvum, convexum. FRUCTUS indehiscens, coriaceus, depresso-reniformis, obliquus, pedicellatus, involucro corollino stellatim patente, maximo suffultus. SEMEN exalbuminosum, decumbens. COTYLEDONES carnosæ, crassæ. RADICULA lateralis, adscendens et in commissuram cotyledoneam replicata.

Classis Linnæana, *Polyandria Monogynia.*

Ordo naturalis, *Terebinthacearum* tribus *Anacardeæ*, Brown.

Habitus: Arbores magnæ facie Semecarpi, omnibus partibus scatentes succo viscido, ferrugineo, a contactu atmosphærico citò in atrum converso; coma latè protensa; folia ampla, coriacea, simplicia, integerrima, decidua, penninervia. Paniculæ

* The Editor has been indebted for this interesting article to Dr Wallich, to whom the Science of Botany is under such deep obligations. It forms part of his splendid work on the rare plants of India.

florum axillares, oblongæ; fructuum amplæ, laxæ, involucris maximis, rufis, demum ferrugineis ornatæ.

Obs. Characteres generici quoad florem præcipuè a *M. glabra*, quoad fructum a *M. usitata* desumpti; habitus ferè totus posteriorem speciem respicit.

MELANORRHŒA USITATA. Tab. 11 and 12.

FOLIIS obovatis, obtusissimis, villosis.

Provenit in convalle magna, Kubbu dicta, regni Munipuriani Hindustaniæ, Sillet et Tipperæ contermini; in imperio Burmanico, et ad oram Tenasserim usque ad Tavoy, inter gradum xxv. et xiv. latitudinis meridionalis. Ipse observavi juxta ripam sinistram Irawaddi fluminis ad Prome; in provincia Martabaniæ ad urbem Martaban, ad Kogun fluminis Saluen et ad Neynti fluminis Attran. Floret initio anni; fructus maturi a fine Martii ad medium Maii.

Nomen vernaculum: Munipurensibus *Kheu*; Burmanis *Theet-tsee* vel *Zit-si*.

ARBOR vasta, ramosa et umbrosa, trunco robusto, cortice sordidè fusco, rimoso, ligno ponderoso, compacto, e fusco rufescente, viliori varietati ligni *Swieteniæ Mahagoni* haud absimili. RAMULI crassi, cylindrici, grisei, villosi, a lapsu foliorum cicatricibus majusculis, frequentibus notati; novelli ferrugineo-villosi. GEMMÆ axillares et terminales parvæ, ovatæ, acutæ, squamis paucis, coriaceis, villosis, citò dilabescentibus. FOLIA versus ramorum extremitates approximata, sparsa, patentia, decidua, obovata, obtusa, rarò subretusa, nunc oblongo-cuneata, deorsum, valdè attenuata, basi acuta, integerrima, subsinuata, lateribus quandoque disparibus; coriacea et firma, spithamæa ad pedalia, utrinque ferrugineo-villosa, mollia, ætate glabriora; suprà atroviridia, subtùs nervo principali crasso, elevato, secundariis numerosis, subobpositis, parallelis, obliquè ad peripheriam excurrentibus, parvâque ab illa distantiâ arcuatim anastomosantibus; venis numerosis, prominulis, reticulatis. PETIOLUS brevis, nudus, villosus, crassus, basi intumescens, suprà planus, a folio subdecurrente parùm marginatus. STIPULÆ nullæ. INFLORESCENTIAM haud vidi; flores aliquot delapsos, emarcidos et cariosos tantùm, observavi. Erant parvi et inconspicui, pedicellis insidentes brevibus, teretibus, villosis. Nullum vestigium calycis nisi forsan lineola obsoleta infra corollam.

Petala 5 lanceolata, acuminata, bilinearia, purpurascentia, uninervia, pubescentia, ciliata, intùs minutim glanduloso-punctata, persistentia, tria exteriora parùm majora. Stamina 20—30 libera, erecto-patula, petalis paulò breviora, toro conico, elevato undique inserta; filamenta glabra, capillacea; antheræ ovatæ, oscillatoriæ, biloculares, utrinque dehiscentes, albicantes. Ovarium obliquè lenticulare, margine altero rectiore, altero gibboso, parvulum, pubescens, pedicello suffultum proprio, inter stamina e centro tori surgente, 1-loculare, 1-sporum; *ovulum* reniforme, sustentum funiculo libero, e fundo loculi orto, secus angulum hujus rectiorem adscendente, apice incurvato. Stylus lateralis e vertice ovarii, subulatus, pubescens, deciduus. Stigma parvulum, convexum. Discus hypogynus nullus. Panicula fructuum terminalis, ampla, patens, laxa, villosa, constans *cymis* pluribus, pedunculatis, oblongis, nutantibus, 6—7-pollicaribus, ramosis, axillaribus foliorum delapsorum. Pedunculi teretes, villosi, infra divisuras cicatricibus bractearum caducarum. Fructus coriaceus, indehiscens, transversè ovatus, depressus, subreniformis, vertice planâ nudus, hinc gibbosior et porrectior (ideoque excentricus), magnitudine cerasi, glaber, reticulato-venosus, venis viridibus demùm nigricantibus, ruber, glaucescens, plenâ maturitate fuscescens, stipitatus *thecaphoro* clavato, tereti, unguiculari; 1-locularis, 1-spermus, involucratus. Involucrum 5- rarò 6-phyllum, patentissimum demùm subreflexum; *foliola* oblonga, obtusa vel paulò retusa, integerrima, 2—3-pollicaria, pubescentia, ruberrima, furfuracea, demùm fusca, coriacea, arida, suprà convexiuscula, subtùs eleganter reticulato-venosa, venis mediis in fasciculum collectis latiusculum, prominulum, ultra basin in unguem brevissimum subproductum. Semen transversè decumbens, magnum. Spermodermium chartaceum, læve, embryonem arctè cingens, vertice crassius et ad latus ejus radiculare exsculptum sulco pro recipienda chorda funiculari lata, plana, e basi fundi oriunda, adscendente, partem spermodermii apici radiculæ oppositam perforante moxque evanida. Embryo magnus, semini conformis, exalbuminosus. Cotyledones crassæ, carnosæ, semiovatæ, obtusæ, gibbosæ, rugosulæ, ad paginam internam planæ arctèque sibi invicem accumbentes, hypogeæ. Radicula brevis, planiuscula, ad [illegible]tem elevatiorem embryonis locata, adscen-

dens, commissuræ cotyledonum adpressa, basi subbifida, apice inclinata et obtusa. PLUMULA minuta, occulta, lanceolata.

The first time I met with this very interesting tree was at a small village below Prome, on the river Irawaddi, where a few had been planted; and on my return from Ava, I found it again in abundance on the hills surrounding the first-mentioned town; but in both instances the trees were without any fructification. In the Martaban province I had the satisfaction of seeing the tree in great numbers in March 1827, on a small acclivity rising behind the town of Martaban. They were loaded with bunches of red, nearly ripe fruit, but were not very large; few only exceeding thirty feet in height, with a short trunk measuring not more than four or five feet in circumference. The leaves had entirely fallen off, and strewed the ground in every direction. At Neynti, a village on the Attran river, behind the military station at Moalmeyn, I also observed a few trees: and lastly, on the Saluen river towards Kogun. Here they were of greater dimensions than those just mentioned; one of them being forty feet in height, with a stem twelve feet long and eleven in girth at four feet above the ground. One of my assistants brought me fruit-bearing specimens from Tavoy on the Tenasserim coast.

I took with me to Bengal a large quantity of ripe fruits of the Varnish-tree, which germinated freely and produced upwards of 500 strong and healthy plants. Out of several individuals, which I had with me on board the ship in which I came to Europe, I succeeded in preserving only one living plant, which was presented to His Majesty's garden at Kew by the East India Company. Subsequently several other plants have been forwarded from the Calcutta garden to England.

Before leaving Bengal I had an opportunity of identifiying our tree with the majestic Kheu, or Varnish-tree of Munipur, a principality in Hindustan, bordering on the N. E. frontier districts of Sillet and Tippera. Mr George Swinton, chief Secretary to the Bengal Government, (to whose kindness I am indebted for much valuable information concerning the produce of this and other useful trees of India,) obtained for me a supply of ripe fruits from thence, which differed in no respect from those I had seen at Martaban. They vegetated

speedily, and produced plants similar to those we already possessed. Captain F. Grant, who has a military command at Munipur, had the goodness to furnish the following particulars.—The tree grows in great abundance at Kubbu, an extensive valley in the above-mentioned principality, forming large forests in conjunction with the two staple timber-trees of continental India, the Saul and Teak (*Shorea robusta* and *Tectona grandis*), especially the former. Numbers of the gigantic wood-oil tree (*Dipterocarpus*) are also found in company with it. The size of it varies; but in general it attains very large dimensions. Captain Grant speaks of trees having clear stems of forty-two feet to the first branch, with a circumference near the ground of thirteen feet; and he mentions that they are known to attain a much greater size. All the individuals grow in the same manner; that is, they reach a great height before throwing out any branches.

As long since as the year 1812, the late Mr M. R. Smith, for nearly forty years an inhabitant of Sillet, and during the latter part of that long period a zealous contributor to the Honourable Company's botanic garden at Calcutta, furnished some very curious information concerning our tree to Mr H. Colebrooke, then in charge of that institution. He must therefore be considered as the first person who brought this valuable tree into notice, although he failed in his endeavours to procure either dried specimens or fresh seeds of it.—I shall here subjoin some of his remarks.

"I have discovered a sort of varnish, which I consider as the identical one made use of by the Chinese in their eastern and north-eastern provinces. It is procurable in great quantities from Munipur, where it is used for paying river crafts, and for varnishing vessels destined to contain liquids, such as oil, ghee (clarified butter,) milk, honey, or water. The drug is conveyed to Sillet for sale by the merchants, who come down annually with horses and other objects of trade. The tree which yields it grows to an amazing size. I am informed that it attains one hundred cubits in height, and twenty cubits in circumference, and even more. It forms extensive forests, which commence at a distance of three days' journey from the

capital, and stretch in a northerly and easterly direction towards China for many miles."

That the *Kheu* which Mr Smith describes is the same as that found by Captain Grant, there cannot be any doubt; nor that it is identical with the *Theet-tsee,* or varnish-tree of the Burmese. It follows, hence, that the tree has a very wide geographical range, extending from Munipur (in latitude 25° N. and longitude 94° E.) to Tavoy (in latitude 14°, longitude 97°.) The valley of Kubbu, which has been ascertained by actual survey, made by Lieutenant Pemberton, to be only five hundred feet above the plains of India, is distant two hundred miles from the nearest sea shore. The tree there attains its greatest size, and I believe it becomes smaller as it approaches the sea on the coast of Tenasserim, where it grows in comparatively low situations.

Our tree belongs to the Deciduous class, shedding its leaves in November, and continuing naked until the month of May, during which period it produces its flowers and fruit. During the rainy season, which lasts for five months, from the middle of May until the end of October, it is in full foliage. Every part of it abounds in a thick and viscid greyish-brown fluid, which turns black soon after coming in contact with the external air. In the *Edinburgh Journal of Science,* vol. viii. page 96 and 100, there are two interesting articles, containing valuable information concerning the varnish produced by our tree, and its deleterious effects on the human frame. It is a curious fact, that, to my certain knowledge, the natives of the countries where the tree is indigenous never experience any injurious consequences from handling its juices: it is strangers only that are sometimes affected by it, especially Europeans. Both Mr Swinton and myself have frequently exposed our hands to it without any serious injury. I have even ventured to taste it, both in its recent state and as it is exposed for sale at Rangoon, and have never been affected by it. It possesses very little pungency, and is entirely without smell. I know, however, of instances where it has produced extensive erysipelatous swellings, attended with pain and fever, but not of long duration. Of this description was the effect it had on the late Mr Carey, a son of the Reverend Dr W.

Carey, who resided several years in the Burma empire. Among the people who accompanied me to Ava, both Hindus and Mahomedans, no accident happened, although they frequently touched the varnish, except in a slight degree to one of my assistants, whose hand swelled and continued painful during two days. Dr Brewster informs me that, after resisting its effects for a long time, it at length attacked him in the wrist with such violence that the pain was almost intolerable. It was more acute than that of a severe burn, and the Doctor was obliged to sleep several nights with his hand immersed in the coldest water. He considers it as a very dangerous drug to handle. One of his servants was twice nearly killed by it.

In the neighbourhood of Prome a considerable quantity of varnish is extracted from the tree; but very little is obtained at Martaban, owing, as I was told, to the poverty of the soil, and partly also to the circumstance of there being none of the people in that part whose business it is to perform the process. This latter is very simple: short joints of a thin sort of bamboo, sharpened at one end like a writing-pen, and shut up at the other, are inserted in a slanting direction into wounds, made through the bark of the trunk and principal boughs, and left there for twenty-four or forty-eight hours, after which they are removed, and their contents, which rarely exceed a quarter of an ounce, emptied into a basket made of bamboo or rattan previously varnished over. As many as a hundred bamboos are sometimes seen sticking into a single trunk during the collecting season, which lasts as long as the tree is destitute of leaves, namely, from January until April; and they are renewed as long as the juice will flow. A good tree is reckoned to produce from $1\frac{1}{2}$ to 2, 3, and even 4 Viss annually, a Viss being equal to about $3\frac{1}{2}$lbs. avoirdupois. In its pure state it is sold at Prome at the rate of one Tical, or 2*s*. 6*d*. the Viss. At Martaban, where every thing was dear when I was there, the drug was retailed at 2 Madras rupees per Viss; it was of an inferior quality, and mixed with sesamum oil; an adulteration which is often practised.

The extensive use to which this varnish is applied, indicates that it must be a very cheap commodity. Almost every article of household furniture destined to contain either solid or

liquid food is lacquered by means of it. At a village close to Pagam on the Irawaddi, called Gnaunee, where this sort of manufacture is carried on very extensively and to great perfection, I endeavoured to obtain some information relating to the precise mode of lacquering; but I could learn nothing further than this,—that the article to be varnished must first be prepared with a coating of pounded calcined bones; after which the varnish is laid on thinly, either in its pure state, or variously coloured by means of red or other pigments. I was told that the most essential, as well as difficult part of the operation consists in the process of drying, which must be effected in a very slow and gradual manner; for which purpose the articles are placed in damp and cool subterraneous vaults, where they are kept for several months until the varnish has become perfectly dry. Another object for which the drug is extensively employed, is as a size or glue in the process of gilding; nothing more being required than to besmear the surface thinly with the varnish, and then immediately to apply the gold leaf. If it is considered how very extensively that art is practised by the Burma nation, it being among their most frequent acts of devotion and piety to contribute to the gilding of their numerous religious edifices and idols, it will be evident that a great quantity of the drug must be consumed for that purpose alone. Finally, the beautiful Pali writing of the religious order of the Burmas on ivory, palm-leaves, or metal, is entirely done with this varnish, in its native and pure state.

I was not so fortunate as to see the tree while in flower, or to procure specimens of it in that state. But the examination of its fruit and of some decayed old flowers, which I found under the trees, has enabled me to establish it into a perfectly distinct new genus. A few days before I left India I obtained specimens in flower, but without any fruit, of a second species from Tavoy, which have aided me in completing the generic character. The genus is allied to most of those which form the tribe of *Anacardeæ*; but it differs from them all in having a calyptriform, one-leaved, caducous calyx, a persistent corolla which enlarges into a spreading involucrum, indefinite stamens,

a free ovarium, and a dry fruit, supported by an unaltered proper pedicel.

I shall conclude by a few remarks on each of the genera to which *Melanorrhœa* approaches.

Anacardium and *Semecarpus* have their fruit resting on an enlarged and fleshy peduncle or torus, and the latter genus has three styles and a distinct hypogynous disc.

Holigarna, a genus to which Mr Brown has referred many years ago in his Appendix to Tuckey's *Expedition to Congo*, is very distinct, by its inferior, adherent fruit. Both *H. longifolia* and *H. racemosa* Roxb. produce an acrid juice, which is used as a varnish. My friend and predecessor Dr Hamilton, by whose death the world has recently lost a very learned and excellent naturalist, informed me that he knew nothing of the Burmese Varnish-tree, if different from a species of *Holigarna*. In the collection of specimens, which he brought away from Ava, and among the descriptions and drawings belonging to them, all of which are deposited in the Banksian Herbarium, I can find no trace of this last-mentioned tree, nor did I meet with it during my visit to that country.

Buchanania has a crenate or lobed disc round the sessile ovarium, 5 styles, and a baccate, naked drupe.

Astronium resembles our genus in having an involucred fruit; but it is the persistent calyx and not the corolla which enlarges; it has besides a sessile ovarium and 3 styles. Its leaves are compound.

Augia of Loureiro (not to be confounded with *Augea* Thunb. a Cape plant belonging to a widely different family,) has polyandrous flowers; but the fruit is naked and sessile. Its leaves are pinnate. According to Loureiro the varnish produced by this tree is that which is commonly used in China and Siam. Neither this nor the following genus has been noticed by subsequent botanical writers.

Stagmaria verniciflua Jack. (in *Malayan Miscellanies*, vol. ii. Append. 3, p. 12,) has a tubular calyx, 5 stamens, a stipitate, 3-celled ovarium, and a naked berry, containing a pseudo-monocotyledonous embryo. It is a native of the Malayan islands, and is the same as *Arbor Vernicis* of Rumphius, [illegible]ing to whom, Mr Jack observes, it is the tree,

which yields the so much celebrated Japan lacquer or varnish, as well as that of Siam and Tonquin; although Loureiro represents the varnish of the two last countries as being the produce of a different tree. Mr Jack adds, that under the article *Sanga* in the *Encyclopédie Botanique*, part of Rumphius's account is given, but by a singular mistake the tree is conjectured to be a *Hernandia*; and that, in the first volume of the same work, the *Arbor Vernicis* is made *Terminalia vernix*; an error which has not been corrected by later authors.

Rhus and *Mauria* differ in having a sessile, naked fruit, and foliaceous cotyledons.—I take this opportunity of remarking that my *Rhus juglandifolia*, which I cannot distinguish from Kæmpfer's *Sitz* or *Sitzdsju*, owes its specific name to a hint thrown out by that author. As there exists a tree so called by Willdenow, Professor Decandolle has changed the name to *R. vernicifera*. The coincidence of the Burmese name of *Melanorrhœa usitata* with that of the Japan Varnish tree is remarkable.

ART. IX. — *Physical Notices of the Bay of Naples.* By JAMES D. FORBES, Esq. Communicated by the Author.

No. VI.—*On the District of the Bay of Baja.*

Nullus in orbe sinus Baiis prælucet amœnis.
HOR. *Epist.* i. 1.

Mons novus; ille supercilium, frontemque favillâ
Incanum ostentans, ambustis cautibus, æquor
Subjectum, stragemque suam, mœsta arva, minaci
Despicit imperio, soloque in littore regnat.
GRAY. *

WE were interrupted in our regular topographical description of the localities in the Bay of Naples, by the discussion into which we entered in the last number of these Notices, upon the curious subject of the Temple of Serapis at Pozzuoli.

* These lines are taken from a beautiful Latin fragment on the Monte Nuovo by our English bard, written with his usual happiness of expression, and containing some passages not unworthy of the days of the classics. It may be found in his life by Mason, Letter 27.

The preceding paper was upon the Solfatara. Resuming, therefore, the natural order, we have first to describe the Cone of Capomazza, which nearly adjoins to that semi-extinct volcano.

Capomazza exhibits a well-defined geometrical form, and has one of the best-marked craters in this neighbourhood, though rather shallow, the sides having yielded somewhat to the influence of the weather. The principal material of which it is composed is a light pumiceous conglomerate, often remarkably silky in its texture, and there are found fragments of real pumice to the size of even a cubic foot.† Adjoining it, is the Monte Barbaro, the "Gaurus inanis" of Juvenal, an appellation which he appears to have given it from the immense vacuity left by its very distinct crater. It was in ancient times fertile, and remarkable for its wines; a great part of it is still covered with luxuriant vegetation, and the interior of what was once the crater forms a valley of singular beauty and romantic retirement, in which there is a solitary cottage. Its structure perfectly resembles that of Capomazza and other neighbouring hills; the disruption on the eastern wall of the crater seems to have been produced at the time of the explosion of the Monte Nuovo in 1538. The indurated tufa of which it is composed is stratified conformably to the conical surface, and the whole hill, according to Mr Scrope †, seems to have been produced by a single eruption. The occurrence of craters in the hills of Capomazza and Barbaro are nowise inconsistent with the principles of submarine action, which we endeavoured to explain in the third number of these Notices; but it seems probable that they belong to a later condition of volcanic energy, and hold an intermediate place between the craters of Astroni and the Solfatara, and that of modern cinereous cones.

But a more important object demands our immediate attention, which, in some respects, may be considered as the most remarkable and interesting in the Bay of Naples; I need hardly say that I allude to the Monte Nuovo or Monte delle Cenere, which appeared suddenly only three centuries ago, the confessed offspring of violent and partial volcanic agency, and the

* Br[illegible]

† *Geological Transactions*, N. S. vol. ii.

more interesting as being one of those rare occurrences which connect the past with the present, and convince us of the real energies of nature, excited in a manner which the ocular testimony of geological facts show must have been much more frequent on the surface of our globe; and by elevating our ideas of the real vastness of the scale of nature's operations, when she occasionally astonishes the inhabitants of this now peaceful earth, exhibiting so many testimonies of a less quiescent state, teaches us to enlarge our conceptions of her embowelled agencies, and gives us some data for the assumption of hypotheses, which would otherwise be groundless and fantastic.

This new mountain appeared on the 29th of September 1538, and the following details of this remarkable phenomenon are drawn from contemporary or immediately succeeding writers *. The neighbourhood of Pozzuoli had for two years previously been perpetually disturbed by earthquakes, but they only became alarming on the 27th and 28th of September 1538, when not less than twenty shocks were experienced in twenty-four hours. At length, between one and two hours of the night (counted from half an hour after sunset) of the 29th, symptoms of a more unprecedented phenomenon manifested themselves; a gulf opened between the little town of Tripergola which once existed on the site of the Monte Nuovo, and the Baths, for which it was much frequented. This village was of considerable size; it contained a hospital for those who resorted thither for the benefit of the thermal springs, and we find it recorded by an eye-witness of the catastrophe, that it had no fewer than three inns in the principal street. The crack in the earth approached the town with a tremendous noise and began to discharge pumice stones, blocks of unmelted lava and ashes, mixed with water, and occasionally flames burst forth. The ashes fell in immense quantities at Naples, and Pozzuoli was deserted by its inhabitants; indeed the shower extended to a distance of thirty miles, and it has even been alleged that there were traces of it in Calabria, 150

* Falconi, *Dell' Incendio di Pozzuoli*, &c. 1538.—Toledo, *Ragionamento del Terremoto del Nuovo Monte.* Napoli Genn. 1539.—And the authorities quoted in the old works of Capaccio and Sarnelli.

miles off. The sea retired suddenly, and it appears from the expressions of contemporary writers that it remained apparently sunk for a considerable time at least, which is confirmatory of the idea endeavoured to be demonstrated when we were considering the level of the sea in relation to the Temple of Serapis, * that a large portion of alluvial land at the foot of Monte Barbaro was then elevated from the bed of the Mediterranean; the fish which were laid dry were caught by country people, as well as the birds which were stunned by the violence of the eruption. It is rather remarkable that several streams of cold water should have issued from the base of the mountain. The great mass of the hill was thrown up in a day and night, though, as the eruption continued at intervals for several succeeding days, very various accounts have been given of the time in which this phenomenon was completed; while twenty-four hours † and thirty-six hours ‡ have been most commonly assigned, some have assigned to it forty-eight hours, § and Breislak, including the whole eruption, has extended it to five days. ‖ The period of one day and night is assigned in the following concise account in a very old work upon Italy: "La Montagna Nuova, o le Cenere; Mons Novus qui Anno 1538, 29 die Septemb. cum ingens terræmotus esset, et incredibili vehementia fuerat spatio unius diei et noctis succrevit, et adhuc magna cum admiratione cernitur." ¶ After the principal eruption of the first and second days, a temporary pause took place on the third, when the clouds dispersing, showed, to the no small amazement of observers, the mountain, of a very considerable size, where formerly there had been a plain with a town upon it. On this day some persons ventured to ascend to the top, where they found a crater a quarter of a mile in circumference, ** in the bottom of which stones were tossed about with great vehemence. On the following, or fourth day, the eruption again

* See last Number, p. 281.
† Sarnelli, *Guida dei Forestieri*, 1688.
‡ Romanelli.
§ Galanti.
‖ *Campanie*, II. 156.
¶ *Itinerarium totius Italiæ*, Colon. Agripp. 1602.
** Giacomo di Toledo's Account, who himself ascended.

broke out at twenty-two hours Italian time, or an hour and a half before sunset: the noise was tremendous, and the quantity of stones considerable; this paroxysm, however, was of short duration, and on the two following days the hill was quiet, excepting the dismissal of a little smoke. On the next day, Sunday the 6th October, several persons again ascended about half the mountain, but being overtaken by another eruption at the same hour as that of the fourth day, some of them were stifled by the ashes, and others injured seriously by the stones which fell. This eruption was accompanied with water, with flames, and, as usual, electrical agencies seem not to have been wanting, as observers have described lightning as one of its features. This concluded the paroxysms of this remarkable explosion. Smoke continued to rise for some time, and at length relapsing into the phase of quiescence, to use a modern term, sulphur began to be generated. Such being a history of its formation, let us take a view of the general features and present condition of this remarkable hill, which appears to be fortunately preserved much in its original state, unlike most of those volcanic productions resembling it, which having been raised from beneath the ocean, soon fell a prey to the degrading influence of its waves.

The Monte Nuovo is situated at $1\frac{2}{3}$ English miles W. N. W. of the town of Pozzuoli, and its base extends to the very edge of the shore of the Bay of Baja, where the sand is still extremely warm. Its height and dimensions have been extremely variously stated, and, had we not now just data for founding our decision, we might be rather at a loss from the mass of conflicting opinions which must ever prevail in the judgment of heights by the eye. Sir William Hamilton* has stated the height at a quarter of a mile, and the circumference at three miles, and in this extravagant estimate he has actually been followed by one of our most popular lecturers in a late small work on Geology.† In older times, when precision was unattainable, exaggeration was to be expected; and accordingly, we find it by one author called 1000 paces,‡ and by another

* *Campi Phlegræi*, i. 49. Fol. Edit.

† Brande's *Geology*. 1829.

‡ Giacomo di Toledo.

a mile high.* Of all writers of the last century Lalande† formed the most moderate estimate, by putting it at two or three hundred French feet; but an eminent Italian mineralogist, Pini, has lately set the question at rest by determining its height very accurately by the barometer, as well as that of many other remarkable elevations in the south of Italy.‡ He found the height of the summit of the Monte Nuovo to be 413.0 Paris feet above the level of the bay, = 440.2 English.

The form of the hill is that of a truncated cone. Its base may be considered as about 8000 feet in circumference, or nearly a mile and a half; § and the truncation, which is estimated at a quarter of a mile in circumference, is, in fact, the edge of a crater of very great size proportioned to the magnitude of the hill; a circumstance confirmatory of a general fact we once took occasion to observe in the description of Vesuvius, that the magnitude of craters is almost universally in the inverse ratio of the size of the volcano. Hamilton observed that the crater of the Monte Nuovo is as deep as the hill is high, and this singular fact is substantially confirmed by the measurements of Pini. He found its depth from the summit to be 395.2 French feet, = 421.2 English. The bottom is therefore only 19 feet above the level of the sea.

The geological structure of the hill requires but little explanation. We have already remarked that it consists entirely of ejected fragments loosely aggregated, and without any appearance of the ejection of lava. From the quantity of water produced by the eruption, it is highly probable that the basis of the hill consists of Tufa, ‖ and, in fact, from its extreme proximity to the sea, its appearance may be considered nearly in the light of a submarine eruption; and perhaps it was under very similar circumstances that Monte Barbaro and some of the neighbouring cones were formed, which have little appearance of that actual attrition of superincumbent water which

* Capaccio.

† *Voyage en Italie*, vii. 353.

‡ *Memorie della Societa Italiana*, vol. ix.

§ Daubeny on *Volcanos*, p. 165.

‖ Sir William Hamilton actually mentions such a tufa of a yellowish colour, and less aggregated than that of Pausilipo. *Cam. Phleg.* Exp. Pl. xxvii.

must have disfigured most of the craters of the Campi Phlegræi with the exception of a very few, if any others really existed. Its component parts are scoriform and disjointed, the greater part being pumiceous, like the neighbouring eminences, but containing less intermixture of felspar. The pumice is also blacker and heavier. The ejected masses are of an ash-gray colour, sometimes trachytic, and often schistose, resembling clinkstone. Mr Scrope mentions some specimens of this rock veined with pitchstone, into which it passes, and also into pumice, the three varieties alternating in a remarkable manner.* Sir William Hamilton describes and figures a vein or bed of lava of which a section is seen in the interior of the crater; but its real nature requires more particular examination. It is said to have been ejected on the seventh day of the eruption, and to have caused the death of about twenty people on the hill, to which we have already alluded. In the bottom of the crater are several caverns which contain alkaline efflorescences, particularly carbonate of soda, and from one, pure and tasteless water in the form of steam arises.

The Monte Nuovo is not a solitary example of such volcanic explosions, which in a few days or hours may elevate an entire mountain; and it is very remarkable that all such explosions on record have been completely submarine. The effect of them has been the production not merely of a hill, but of an island. It may be instructive to notice briefly the accounts we have received of such phenomena.

The most remarkable in every way occurs likewise in the Mediterranean. It is the Island of Santorini in the Grecian Archipelago, and its numerous small dependents. The larger mass, which was anciently called Thera, and now Santorini, according to the account of Pliny, was itself raised from the bed of the sea; and from its structure and appearance it seems extremely probable that it was so at an early period, though the Roman naturalist has mixed his narrative with some inconsistent details. In form it much resembles the Island of Nisida near Naples, already described, having a harbour of great depth at one side perfectly resembling a crater, communicating at one side with the sea. The whole structure

* *Geological Transactions*, N. S. vol. ii.

of the island is volcanic, and has very often been subjected to remarkable shocks. Pliny relates, that, posterior to the appearance of Thera, and Therasia, the modern Aspronesi, to which he gives a similar date, a small island named Hiera was elevated, which now forms, according to Dr Daubeny, the Burnt Island, or Great Cammeni. In A. D. 46, in the reign of Claudius, a new small island was raised named Thia, which, as it does not now exist, has been very plausibly conjectured to have been united to it in a succeeding convulsion of 726, when, according to the testimony of Theophanes, a Greek author, a new island rose and was joined to Hiera, though more probably the island was not new, but the ancient Thia brought into contact with it. In 1457 an immense quantity of rocks were raised to five or six feet above the level of the water, forming a basin of a circular form, into which the sea entered. In 1573 the lesser Cammeni, situated as well as the larger island of the same name in the crater of Santorini, was thrown up. In 1638 there was an eruption of pumice. In 1650 a bank was formed ten fathoms under water. At length, on the 18th of May 1707, an earthquake was felt at Santorini, and on the 22d it was repeated. On the 23d of May, New Stile, at break of day, an island was discovered rising between the great and lesser Cammeni. After a few days it had acquired a height of fifteen or twenty feet. It is remarkable that smoke first appeared only on the 16th of July,—a fact affording some remarkable illustrations of the evolution of elastic fluids as connected with volcanic inflammation. The discharge of sulphuretted-hydrogen-gas became so abundant, as to be extremely distressing to the inhabitants of the Island of Santorini. About this time also a reef of black rocks rose, forming a separate island, but which, from subsequent accumulation, became the centre of this new-ejected mass. From this period the water of the sea was much affected; its colours were various; the fish died; and so great a temperature it assumed, that no boat could approach the new island. The gradual accumulation of matter is one of the most extraordinary features of the phenomenon. On the 21st of June it was only half a mile in circumference, * which, by the 20th of Novem-

* Sherrard, *Phil. Trans.* xxvi. 67.

ber, had increased to three miles,* and it was then thirty-five or forty feet high. Things continued much the same with various paroxysmal eruptions, till February 10, 1708, when they became more violent and tremendous, with alarming subterranean noises. These symptoms continued long without any particular result. In May of that year the mountain had increased to 200 feet in height, and five miles in circumference.† The state of things remained much the same for a considerable time, and in July 1711, the island was six miles in circumference. In 1712 tranquillity seems to have been restored. This account contrasts remarkably with the rapid elevation of the Monte Nuovo. We must, however, remember that the whole mass to be elevated at Santorini was enormous from the great depth of the water above which this island, merely the summit of a vast cone, had to be raised. In 1708 Father Goree found no bottom near its shore with a line of ninety-five fathoms. In its way the island of Santorini is not less instructive and remarkable than the case before us in the Bay of Naples. It forms an obviously valuable lesson for the study of geologists; and its future paroxysms may yet have in store uncommon treasures for the diligent observer of the effects, and speculator upon the final causes of volcanos, in this comparatively advanced period of geological science. We observe, that in the reports of the progress of the French commission at this moment employed in the investigation of the natural history and antiquities of Greece, that the distinguished Bory St Vincent has examined the Island of Santorini, and thinks that some speedy convulsion is at present menaced.

An effect of volcanic explosion similar to that of the Monte Nuovo, is related to have taken place off the coast of Iceland in 1563, by the formation of a new island a mile in circumference, at the period of the eruption of Shaptaa Jokul in 1783; but we have no details to give of particular importance. It disappeared the following year. It is likewise sufficient to mention one of the Aleutian islands, which Kotzebue relates, on the authority of the Russian hunters, was elevated from the bed of the ocean in 1814.

A very curious and interesting phenomenon occurred in

* Bourgignon, *Phil. Trans.* xxvi. p. 200. † Father Goree, Ib. xxvii. 354.

1811, off the Island of St Michael, one of the Azores. During the preceding year, and that spring, earthquakes had been frequent and severe, and in February, a shoal was formed by a submarine eruption at two miles from shore. But on the 13th of June, another explosion took place at two miles and a half beyond the first, by which an island 300 feet high was formed, having a crater 500 feet in diameter. It was discovered by the crew of the frigate Sabrina, and thence took that appropriate name. The action of the waves, however, soon undermined its loosely aggregated structure, and in a few weeks it sunk into the ocean. Some time since, there were eighty fathoms of water above where it stood. Its site had previously been occupied by islands formed in 1691 and 1720, which had successively disappeared. In 1638, an island had also been formed off St Michael's, and this year was rather remarkable for the occurrence of volcanic explosions. Not only this island was elevated, but we have already noticed that an eruption of pumice took place at the Island of Santorini, and the Peak, a very lofty volcanic mountain in the Island of Timor, one of the Moluccas, had its top blown off by an explosion the same year, and replaced by a lake.

These illustrations will not, I think, be considered out of place in the discussion of the history and features of the Monte Nuovo. The phenomena are of the most real, as well as of the deepest and most enchaining interest; they must be generalized, and not studied individually; they must be treasured as the oracles of nature's modes of action, sparingly distributed, and worthy of all our care in the skilful combination and refined analysis of them. The late date of geological science has prevented the acquisition of much information from occurrences so rare, that their epochs are not so much dated by years as by centuries; and from the length of time which has elapsed since any very striking event of the kind occurred in Europe, we are authorized by the doctrine of chances to suppose, that the period of some irregular exercise of volcanic agency is not very distant. Breislak has remarked, that for a long period every second century has produced some convulsion in the Bay of Naples; the eruption of the Solfatara in the 12th; of Monte Epomeo in Ischia, in the 14th; of the Monte Nuovo in the

16th. The 18th has already passed over, distinguished only by the unprecedented number of eruptions of Vesuvius in the latter part of it, which, by giving vent to the eruptive force, may perhaps have checked the disposition to any irregular efforts.

It has been a subject of some dispute, whether or not the Lucrine Lake was filled up by the eruption of the Monte Nuovo, or whether its destruction was owing solely to the decay of the stupendous Julian Port, by which it was united to the Mediterranean, forming a large portion of the harbour. Both causes have probably contributed to the effect. The bulwark of Augustus has obviously sunk under the prophetic "Debemur morti," of Horace,* and one fragment alone, named "Lanterna di Porto Giulio," remains to mark the labours of regal greatness; but besides, since the junction of the Lucrine Lake was artificial, when the protecting mole was removed, the entrance was probably again closed, or at least the changes of relative level of the sea and land would probably detach it; and since the Monte Nuovo now appears, by all accounts, to stand so directly on its site, as to give rise to the conjecture, that the Lucrine owed its existence to the crater of a pre-existent volcano, it seems also probable, that it was almost entirely filled up by that explosion, the miserable marsh which now alone can be identified with it, more than deserving the appellation of "diu sterilis palus" which the Roman poet applied to it in its primæval state. Though contemporary authors do not expressly mention the destruction of the Lucrine Lake in 1538, we think there is some room for confirming the idea. Giacomo di Toledo, as quoted by Sir William Hamilton, distinctly says, that the communication of Lake Averno with the sea was hindered by the eruption, which could only be through the Lucrine Lake; and therefore leads us to the idea, that the latter was not entirely separated at that period from the Mediterranean, till the elevation of the plain in which it lay, which we have already considered to be demonstrated. Besides, Capaccio, who, from the old date of his writings, had the best means of information, speaks of the

* *Ars Poetica*, v. 63.

annihilation of the Lucrine Lake, as a thing understood; "Monte di Cenere, qual' e quello c' hà coperto Tripergolo, e'l lago Lucrino in Pozzuolo." *

Lake Avernus, or Lago Averno, was anciently united artificially to the Lucrine. This communication has, however, disappeared. The lake is nearly circular, and about half a mile in diameter. † It appears certainly to occupy the crater of a volcano, whose geological date is perhaps coincident with that of Astroni, already described. The surrounding soil is chiefly composed of ordinary yellow tufa, of which we have a section in the Sybil's Cave, as it is vulgarly called, on its bank; the history or purposes of which, it is not our present object to discuss. It contains, however, a singular apartment, in which occurs a slightly tepid spring. The fancy of the poets, and the superstition of all ages, has assigned to Avernus an unfathomable depth; this illusion has, however, been ruthlessly dissipated by the nautical energy of Captain Smith, ‡ who found the extreme depth to be from 100 to 102 feet, beginning to shoal from about forty feet from the bank. Regarding the ancient ideas of the pestilential influence of the neighbourhood of Lake Avernus, I confess that I never saw any reason to disbelieve the facts, suposing them only a little over-coloured, and shrouded with the grand superstitions of mythological poetry. Avernus is indeed now open and smiling; no natural symptoms now conspire to remind the classic traveller of the "atri Janua Ditis;" the birds now fly untroubled over its once fatal surface; and all nature shines in her most cheerful colours, where we ought to find Stygian shades, mournful sounds, and flitting ghosts. Very much is to be imputed to the change of men's minds, yet art and nature have done much to change the spot. According to all our ideas, mephitic vapours, such as might naturally be exhaled from an extinct crater, such as

* *Antichita di Pozzuolo*, 1652. p. 164.

† 300 canne; Ferrari, *Guida*.

‡ *Geological Trans.* N. S. ii. 347. The usual uncertainty prevails on the size and depth of Avernus. Ferrari makes the former 95 canne, or about 210 yards; Romanelli has it 1000 palms, or 290 yards, and makes the circumference three miles, instead of one and a half, as we have above given from I Could Captain Smith have found it in fathoms instead of feet?

Avernus undoubtedly is, would produce the pestilential effects described, and under the confinement of the bushy and damp forests, which at one time shrouded the now peaceful banks of the lake, might easily be accumulated in noxious strata.

M. Bory St Vincent informs us, on the testimony of an older writer, that in an eruption in the Island of Lancerote, about a century ago, vast streams of deleterious vapour were emitted, destructive of animal life, and he observed seven or eight birds approaching one of the streams, fall as if "asphixiès,"—a case remarkably in point; and Sir William Hamilton tells us, that during eruptions of Vesuvius, he has picked up dead birds frequently on the mountain. It is impossible to suppose that, without some foundation in truth, the ancients could have given the appellation which signifies "without birds," (from the Greek word Ἄορνος.). Such etymologies, however they may be interlarded with fables, ought not to lose their due weight in the interpretation of natural facts; and the Roman poets, while they appeal to the original derivation of the name, obviously give us to understand that the cause still existed. Thus Lucretius:

> Principio, quod Averna vocantur, nomen id ab re
> Impositum est, quia sunt avibus contraria cunctis
> E regione ea quod loca cum advenêre volantes,
> Remigii oblitæ pennarum vela remittunt
> Præcipitesque cadunt molli cervice profusæ
> In terram, si fortè ita fert natura locorum
> Aut in aquam. ———————
>
> *De Rerum Nat.* vi. 740.

Respecting the change which we now observe, the classic writers have not left us in the dark. When the Julian port was made, the dark overhanging woods of Avernus were cut down, and the purifying waves of the sea admitted by a canal into its once impure and Stygian waters. Thus transformed, Avernus bore no longer its original character, and the change which was wrought upon the character of the lake was expressed by the prodigies which are recorded to have happened. The Gods, we are informed, did not look with indifference upon these sacrilegious alterations; and the statues placed among the once sacred groves, gave symptoms of terror and super-

natural dismay. These objects of popular belief, or poetic fancy, absurd as they may be, indicate not the less the existence of such a real change; and we have the express testimony of Silius Italicus, a writer of the first century, when probably the lake much resembled its present condition:

> " Ille olim populis dictum Styga, nomine verso,
> Stagna inter celebrem *nunc mitia* monstrat Avernum;
> *Tum* tristi nemore atque umbris nigrantibus horrens,
> Et formidatus volucri, lethale vomebat
> Suffuso virus cœlo ——————— "
>
> SIL. ITAL. lib. xii.

Lake Avernus, through the medium of the Lucrine, communicated with the Bay of Baja, near the foot of the Monte Nuovo. In pursuing a westward course along the margin of the Bay, we find about two-thirds of a mile to the south of Lake Avernus, an object of very considerable interest. This is the *Stufe di Tritoli*, or Baths of Nero, the most remarkable thermal spring in the Bay of Naples, and of which I gave a brief and imperfect description some years ago in this *Journal*. The derivation of the name is somewhat doubtful; it may, however, be not improbably referred to the Greek word Τριταῖος, from the efficacy of the vapour-baths in tertian fevers. That they are actually the Baths of Nero, we have very good reason to believe, since the villa of that tyrant was certainly in that neighbourhood, and these *Stufe*, as they are called, so pre-eminent as to deserve Martial's facetious contrast of their virtues, with those of their royal owner: " Quid Nerone pejus? Quid thermis melius Neronianis?" The only accurate account and plan of the singular passages connected with these thermal springs, and which are cut out of the rock, is to be found, as far as I know, in a small and neglected book of a century and a-half ago, the " *Guida de' Forestieri per Pozzuoli*," by Sarnelli, in which is a ground plan of these singular passages, from the designs of Bulifon. By the distinct and accurate details of that little work, and the results of personal and attentive observation, I shall be enabled to correct the mistatements and exaggerations of even modern travellers and guide-books.

At about thirty feet above the sea, we enter a passage cut out of the tufaceous rock, which conducts us to several apartments,

which are occasionally appropriated to the service of the invalids who make use of the vapour-baths, and the necessity of partly undressing, which is abundantly enforced by the example of the *Custode* himself, together with his tales of wonder, seems to have allayed the curiosity of many visitors, who, in their books, have given us idle tales of danger. It cannot be denied that a first visit is a little startling in these subterranean dwellings of Pluto, and the supersaturation of the air with aqueous vapour gives it a peculiar and stifling feeling, and perhaps there are few who have not felt some disposition to return after advancing thirty or forty yards. The passage is narrow, perhaps not three feet wide, and on either hand are niches cut out in the tufa where patients may lie exposed to the force of the steam. At a distance of sixty paces from the entrance, during which the path is pretty level, and five or six feet high, the inconvenience derived from heat and difficulty in breathing is greatest, for we afterwards turn pretty sharply to the right, and, descending gently, breathe a more tolerable atmosphere, though nearer the source of heat. After going about sixty paces farther,* I reached the hot spring, and, by keeping my head near the ground, I found that I could have remained a considerable time without much inconvenience. The pool of water there formed seemed to have accumulated in a passage originally cut to a greater length, since the water rose to the roof from its slanting direction. From the confusion of the moment, and the apparent unnaturalness of a spring hotter than the hand can bear, I put my finger into it, but rapidly withdrew it, with a sensation nothing short of the heat of boiling water. I held in my hand a mercurial thermometer of Cary's, which I dipped into the spring, and reading off the indication by the light of a torch carried by our guide, with as much deliberation as possible, I found it to be 183°.5. I had reason to believe, however, from previous observation,

* These distances are from the measurements of Bulifon. In my paper written at Rome in the close of 1826, a few weeks after visiting these baths, and inserted in this *Journal*, I estimated the distance to the commencement of the descent at forty yards, and the descent itself at as much more; these perhaps do not differ much from the sixty paces given in the text, at least it is not more than might have been expected from the vagueness of my observation under such circumstances.

that at this part of the scale it would require a reduction of 1°; I therefore placed the temperature at 182°.5. It was on the 11th of December 1826. This observation is the more valuable, that, as far as I know, it is the only one affecting accuracy yet given to the world. Most authors have asserted that the water boils; * and Romanelli distinctly asserts that its temperature exceeds 80° Reaumur, though it is obvious enough he could never have tried it. Breislak, † with great moderation, says, "La chaleur qui y regne a une grande intensite; l'obscurité du lieu, et la vapeur qui s'attache à la surface de tous les corps, empechent de la mesurer avec precision, mais elle passe les 60 degrès de Reaumur." But 60° R = 167° Fahr. so that Breislak comes below the mark.

It is not surprising that the idea of so great a heat as this should have been alarming to those unacquainted with the powers of animal life to withstand intense heat, when we reflect that the time is not very long past when the experiments of Blagden and Fordyce put this question in its true light. The most intense heat, however, sustained by these gentlemen ‡ seems to have been in dry air, which has far less effect on the body than an atmosphere loaded with steam, which, by condensing on the body, parts with a large share of its caloric. These experimenters, however, found far less inconvenience than they expected from the great temperature. Their bodies when exposed to steam of a moderate temperature became inflamed, the pulse much quickened, but the heat of the body little affected. In passing to the cold air they felt little inconvenience, probably from the excess of moisture and perspiration which defended the pores of the skin from the rapid effects of cold. The degree of perspiration in the heated baths varied very much in different persons, and was greater in the dry than vapour stoves. Dr Fordyce having remained fifteen minutes in a vapour stove at a temperature of 130° (greatly lower than that of Nero's Baths,) his pulse rose to 139, and he was much more affected than by dry air of a greatly higher temperature, which he justly imputed to the

* Hamilton, Ferber, Orloff, Lalande, &c.

† *Campanie.* ii. 173.

‡ *Phil.* [illegible]. iii. 484.

heat given out by the steam, and to the want of evaporation from the body, the air being in a state of saturation with moisture. All the general phenomena experienced at the Stufe di Tritoli are similar to those observed in the cases of artificial experiment. The inflammation of the skin where exposed to the steam is remarkable, and gives those who merely see the guide return from the bottom a great idea of extreme temperature. The streaming of condensed moisture from the body has likewise the appearance of natural and excessive perspiration, in which respect, however, as I have remarked, people are very different. In my own case, the perspiration was considerable, independent of condensed vapour. The extreme narrowness of the passage, and the nearness of the approach to the subterranean source of heat, preserve in these singular and obscure grottos the most regular and intense temperature, so that it is more insupportably hot at the turn of the last branch, sixty paces from the spring, than over the very steam as it rises from the water itself. The water is brackish, but seems wonderfully little mixed with adventitious matter. Fish boiled in it has no disagreeable taste. I regret that I have no analysis to give of its contents. According to the custom of the place, the guide takes some water in a pail from the spring and puts fresh eggs into it, and, carrying them to the open air, notwithstanding this effectual cooling, they are in four minutes very pleasantly boiled. On leaving the baths, I felt not the slightest disagreeable effect from almost immediate exposure to the open air between 50° and 60°, but, on the contrary, on re-embarking at the foot of the hill, experienced a delightful sense of warmth over my whole body. After this simple statement, which may give some idea of these baths, it will perhaps afford the reader some amusement to quote the prevailing opinions expressed in tours and guide books, about twenty of which, pretending to describe the spot, I have consulted, of whose authors, it is evident that not above two or three ever reached the thermal spring,* some proceed-

* Of the following authors, Breislak, Swinburne, Ferber, Eustace, Lalande, Starke, Orloff, Jorio, Capaccio, Sarnelli, Ferrari, Hamilton, Romanelli, Galanti, Soulavie, Reichard, Matthews, Tenore, Vasi, Giustiniani, and the authors of the "*Voyage Pittoresque*," only Breislak, Sarnelli, (or

ing ten, twenty, or thirty paces, as their courage lasted. Yet to such inaccurate observers is Italy still indebted for her illustration; and the absurd tales of Custode and Valets-de-Place, are pawned off upon the credulous world as the results of laborious research and acute observation!

"At the bottom of the bay" says the sagacious Swinburne, who probably never attempted to enter the stove, "and at the foot of the steep rocks which serve as a foundation to the ruins called Nero's House, are some dark caves of great depth, leading to the hottest of all vapour-baths; nobody can remain long in them, or indeed penetrate to the end without *an extraordinary degree of strength and resolution.* The springs at the bottom of the grotto are so hot as to boil an egg *hard, almost instantaneously.*"

"In one of these grottos," says the would-be philosophic Ferber, "which is obliquely running into the rock, the heat is so intolerable, that naked people, in two minutes, distil with sweat. The heat stopped my breath, and I could not go in them above *thirty paces.* Distant 130 paces from the entrance is a hot aluminous water about one palm deep, which *hardens eggs in a moment.*"

The more observant and accurate Lalande, while he expresses himself not ignorant of the great heats which have been supported in artificial experiments, gives this rather overstrained account. "La chaleur de les souterrains est si grande, qu'au bout de *dix pas on est, pour ainsi dire, suffoquè*, et il faut de l'habitude et de la force pour aller plus loins; les paysans y vont avec facilité, mais ils sont presque nuds, et ils reviennent au bout de deux minutes, tous couverts de sueur, le visage aussi inflammè que s'ils avoient été dans un four."—"Ce n'est pas sans peine et sans danger," says Orloff, *

rather Bulifon,) Romanelli, and perhaps the authors of the "*Voyage,*" can be inferred to have reached the hot spring. It is not even alluded to by Spallanzani, and many other writers I have consulted upon this part of Italy. There is a curious work I have not elsewhere mentioned, in the Advocates' Library, giving some account of the Stufe di Tritoli, entitled "*Synopsis eorum quæ de Balneis aliisque Miraculis Puteolanis scripta sunt.* Auct. Jo. Fran. Lombardo, Neapolitano." Venetiis, MDLVI. small 4to.

* *Mémoires sur Naples,* v. 343.

" qu'on y penetre, tant le chemin, qui a une pente trés rapide, est etroit et glissant, et tant la chaleur devient insupportable plus au descend vers la source ou bain dont l'eau est *toujours bouillant.*" An eminent topographical writer, Reichard, in his larger work upon Italy, has added a newly invented feature to increase the horrors of the place, and, as he did not go to the bottom himself, was probably put upon him by the egg-boiler to enhance the merit and risk of his services. This writer records that there are sometimes united " *traits de feu avec ses bouillans !*"

One of the guide books published in Naples says, " Gli uomini practici vanno con facilità sino al fondo, e prendono l'acqua sorgente ch'è quasi bollente: vi entrano essi quasi nudi, ed in due minuti escono tutti grondanti di sudore, e colla faccia infiammata, come se fossero usciti da un forno. Chi poi non è assuefatto, dopo *dieci passi di cammino*, si senti suffocare, e mancar le forze per andar piu avanti."* But a still more inexcusable perversion is by an author of learning and some credit, who, though living within a few miles of the spot, seems never to have formed experimentally just ideas on the subject. " Badi bene il forestiere," says he, " non farsi trasportare dalla sconsigliata curiosità, di calare per quelle tortuose grotte fino al basso, ov'e l'acqua bollente, *perche potrebbe rischiarvi la vita.*" †

These authorities, selected from many others of the same character, show sufficiently the mistaken notions which have been so long circulated from hand to hand. The very simple description of Breislak is the only one I have seen deprived of this mysticism; but though he is obviously one of the few authors who have gone to the bottom themselves, he has not given us any lively description of the appearances or phenomena. In fact, the quackery of guides and guide-books seems to have deterred our natural observers from inspecting this curious spot, so near approached to that surprising focus which has maintained its intense temperature so many centuries, with unabated vigour, without any indication, direct or indirect, of that mysterious fuel by which it has

* Ferrari. † De Jorio, *Guida di Pozzuoli*, 138.

been fed, and which affords so remarkable a subject of speculation in this age of geological inquiry. * It has been supposed by some, that the temperature has increased greatly since the day of the Romans; † this, however I think, is improbable from the strong expressions of Pliny; "Tanta eis est vis ut balineas calefaciant, ac frigidam etiam in soliis fervere cogant. Obsonia quoque percoquunt." ‡ Yet, notwithstanding the continuance and intensity of the heat, the water, as we have already remarked, is almost pure; it evolves no sulphuretted hydrogen, like the other springs of this neighbourhood, and appears to have no action on the tufaceous rock § through which its vapours have circulated for hundreds or thousands of years. I must not close this description without adding, that the spring is not the only termination of this excavation; various branches strike off from the first one, and constitute no less than seven terminations. The only tolerable description I have met with of these intricate passages is in a curious work, a century and a half old, already alluded to, and which contains an original ground plan ‖. Some of these are extremely low, not above two and a half feet in height, of which the floor composed of sand has a burning heat. One of the most inaccessible terminates in a cross, in the centre of which is a dry well, from which issue vapours of high temperature. The confinement and remoteness of this grotto occasions an extremely insupportable atmosphere, and it is said to be dangerous to visit these remote recesses, though they contain no hot spring.

Besides the Stufe de Tritoli, which, with great probability, may be considered the true Baths of Nero, others of less importance are distributed over the same neighbourhood. Baja was famous for the variety and multiplicity as well as the excellence of its thermal springs;

> "Baianos sinus, et fœta tepentibus undis
> Littora.——————————————"
>
> ITAL. Lib. iii. 4.

* Neither Professor Daubeny nor Mr Scrope, our two principal volcanic writers, seem to have visited these stoves.

† Orloff, v. 332.

‡ Lib. xxxi. 2.

§ Breisla[illegible]

‖ Sarne[illegible]oli, 1688.

If we descend to the shore below these baths, we find the Bay of Baja crowded with the ruins of villas, which once belonged to wealthy Romans, disputing with the waves the possession of the bank *. Many of the Roman Emperors selected this spot as their chosen retreat; and, guided by the hand of fancy and the records of classic antiquity, we may trace the villas of Julius Cæsar, Nero, and Adrian, of Pompey, Marius and Hortensius. But here it is not our object to dwell on these delightful and interesting associations. We would point rather to a remarkable fact which these ruins present. Many of them are built in the style of the *opus reticulatum*, in which the lozenge-shaped pieces which invest the exterior of the wall are formed, as usual, of the common stone of the country, which is here the ordinary friable tufa †. They were imbedded in mortar formed of Pozzuolana of the finest description,—a cement which takes its name from this vicinity, and the remarkable fact is, that where exposed to the water, the reticulated masses have, by long attrition, been washed out, while the thin dividing portions of cement stand to this hour a monument of its durability, and the masses of building present the most curious honey-combed appearance. The *Pozzuolana* is dug in the immediate neighbourhood, namely, just behind the three temples at Baja, bearing the names of Venus, Diana, and Mercury. It has there a pale grayish colour, considerably differing from the brownish black dug near Naples, and the deep red of the Campagna di Roma. To nothing have the architectural remains of the ancient Romans been so much indebted for their durability as to this invaluable production of volcanic countries; and a want of attention to this circumstance has superinduced the most unfounded supposition regarding the means employed by the Romans to harden their mortar, at least when applied to buildings in Italy.

By examining merely theoretical descriptions of the Pozzuolana, we should not perhaps find it easy to separate it from the ordinary tufaceous formations round Naples, with which indeed it has been too much confused, which might lead readers to imagine that the hill of Pausilipo was composed of it, and that

* See Hor. Carm. ii. 18. † See this *Journal*, No. xvii. p 30.

the grotto was cut out of the same material. However difficult the mineralogical characters may be to separate, the real difference exists. The common tufas of the Bay of Naples are consistent, homogeneous, capable of being cut and chiselled, and, though porous, appear to have no particular action upon water capable of making them applicable as cements. The Pozzuolana, again, is extremely friable, gritty and harsh to the feel to the last degree, quarried rather like sand than stone, and exercising a very remarkable power of adhesion, when applied to the purposes of a cement. The limits to which I must confine myself oblige me to do little more than touch upon the remarkable properties of Pozzuolana, which seems to deserve more attention from practical chemists than it has yet received.

The ancients were well acquainted with its value, and it is the "Arena Fossicia" of Vitruvius, but also called by him "pulvis Puteolana *." When it could be procured, as in the neighbourhood of Rome and Naples, no less than three parts of it were used to one of lime. Its intrinsic value has been duly appreciated in various parts of Europe; and in the great undertaking of building the Eddystone Lighthouse, Mr Smeaton employed no less than an equal quantity of Pozzuolana mixed with lime, for the mortar to be used under water.

It is remarkable that different rocks of volcanic origin have been used for the same purposes. A kind of vesicular basalt is quarried in great quantities at Andernach on the Rhine, and transported to Holland for building under water: A similar kind of rock, which is called trass or tarrass, (and is nearly assimilated to the pumiceous conglomerates of Hungary, †) is found at Coblentz, ‡ and might probably be appropriated to the same purposes. It seems to have the most important characters of the grey Pozzuolana of the Bay of Naples. §

* Vitruv. Lib. ii. 4, and ii. 6.

† Daubeny on *Volcanos*, p. 171.

‡ *Annales des Mines*, xxv. 366.

§ It seems that some of the extinct volcanic matter in the south of France is, or might be, applied to similar purposes. See Soulavie's edition of Hamilton's Works, p. 476.

What may be the principle of the astonishing hardness of the mortar made with this material is a curious subject of inquiry. According to the analysis of Bergman it consists of 55 to 60 parts of silex, 19 to 20 of argillaceous matter; 5 to 6 of lime, and 15 to 20 of iron. It is, as we have just remarked, harsh to the feel and brittle. It has a specific gravity of 2.570 to 2.788, but rarely 2.8; it has an earthy smell, and is not diffusible in water unless when heated. It does not effervesce with acids. When hot it is magnetic. The iron may justly be considered as its intrinsically important ingredient, and Mr Kirwan ingeniously supposes its peculiarity to exist in its pure and magnetic form, by which it is rendered capable of decomposing the water with which it is mixed, and which, therefore, accounts for its rapid absorption of that fluid. The clay contributes greatly to give it a plastic tenacity, and, according to this theory, the principal effect of the lime is to favour chemical action and solution by its evolution of heat. This supposition is rendered the more probable by the circumstance, that the best imitation of Pozzuolana mortar was found by Mr Smeaton to consist in mixing granulated particles of the sparks of iron from forges with the other ingredients of cement.* This may also lead to some conclusions on the original cause of the differences observed between the tufas and the Pozzuolana, with which they are occasionally interstratified near their surface. The ingredients are undoubtedly almost the same; but in the one case, the iron, having already exerted its adhesive influence, has combined the loose sandy particles into the form of a rock, and is itself transformed into an oxide incapable of repeating the operation; while, in the other, the volcanic sand, fresh from the igneous focus, was probably deposited by the eruption of some neighbouring volcano, just as the hills, produced by submarine action, were emerging from the waves.† This might, I think, explain most of the peculiarities of this singular substance,

* The distance from which real Pozzuolana must be brought has given rise to several other imitations of it. One by M. Delahaye-Dumeny was secured some years ago by patent in France.—*Ann. des Mines*, xxviii. 384.

† See Number III. of these Notices.

especially from its occurrence near the surface of such hills, as in the remarkable section formerly described, made by the Strada Nuova in passing over the hill of Pausilipo. We may, perhaps, have occasion to return to this subject.

The Baths of Nero, the Pozzuolana quarries, the castle and village of Baja, and its three temples, are situated on the western boundary of the Bay of Baja or Pozzuoli, forming a neck of land projecting towards the islands of Procida and Ischia, terminated by the Capo di Miseno. The east side of the promontory, therefore, bounds the bay, and commands an extensive prospect of Naples, Vesuvius, the Sorrentine Hills, and the more distant Apennines, while, from the opposite side, the wide expanse of the Mediterranean, and the trendings of the coast of Italy, may be seen as far north as Mola di Gaieta. On this shore, at no great distance from Baja, stands the venerable rock of Cumæ, the first landing-place of Æneas in Italy Of this spot, so interesting in the earlier classical history of Italy, I have little to say. The rock on which its fortress once stood, though it has lost the figure, retains the character of a volcanic cone: * and near it may be seen one of the densest masses of lava in the form of a current in the Phlegræan fields. Near the ancient gate of Cumæ, now called the Arco Felice, I picked up perfect specimens of pumice, —a substance which we have elsewhere remarked to be rare in the active emissary of Vesuvius. A little to the south of Cumæ, approaching the Capo di Miseno, is the only remaining representative of the once sombre and poetical Acheron; it is the Modern Fusaro. This lake, which has an open and cheerful appearance, lies in the flat alluvial land which here forms the shore of the Mediterranean; it is so low as to admit of a communication with the sea, and is at present chiefly remarkable for its excellent oyster beds, the products of which are much and justly esteemed at Naples. Perhaps it is worth mentioning that these shell-fish have a slightly black appearance, and that within the shell there is invariably a cavity, which, on breaking the pearly crust which covers it, is found to contain a portion of fluid with a strong sulphureous smell; as if to bear witness to the Plutonic origin of the very inhabi-

* Scrope, *Geological Trans. ut sup.*

se mythological scenes, where each superstitious
l a local habitation and a name. But the " Ache-
ow deprived of its mystical accessaries, and
o is adorned with a pleasure seat of the
while under the beauty of Italian sunshine
ssible to imagine the gloomy regions of Tarta-
t of Charon, or the desponding shades.

e to the south of Fusaro rises the Monte di Procida,
extends nearly to the termination of the promontory,
d takes its name from the island adjoining the coast, which it overlooks. According to Mr Scrope it is composed of a trachytic conglomerate in irregular strata containing blackish glassy felspar, and alternating sometimes with porphyritic pitchstone. The conglomerate includes fragments of granite and syenite. The hill terminates in the sea at a remarkable spot named Scoglio delle Pietre Arse (Rock of the Burnt-stones) consisting of a pitchstone covered with earthy lava containing half melted fragments. The pitchstone is in some places quite perfect, and contains felspar crystallized in six-sided prisms, which have been observed half an inch in length.* Some beautiful gradations of the pitchstone into pumice have been here observed. The former is remarkably brittle. Rocks corresponding to the " Scoglio delle Pietre Arse" are found on the opposite coast of Procida, as we shall more particularly notice in the next number of these papers.

We thus reach the Capo di Miseno, the ancient Misenum, where the Romans had a harbour for their fleet stationed here. It affords on the east side a fine section of a volcanic eminence, being on that side much degraded, as may indeed be pretty generally observed in the volcanic cones of this neighbourhood. † Near the foot of the hill there rises from the sea a spring of fresh water similar to the remarkable one observed in the Gulf of Spezia near Genoa. ‡ As this was a marine station, it seems that the Romans were peculiarly anxious to obtain for it a good supply of water, as for this purpose only can the remarkable edifice in the vicinity called the Piscina Mirabile have been designed. It is an immense qua-

* Spallanzani's *Travels*, i. 139.
† Breislak.
‡ Lalande, *Voyage en Italie*, vii. 378.

drangular apartment under ground, to which we descend by 40 steps; it is 230 English feet long and 97 broad, and is supported by 48 square pillars in four rows, which are united by small arches at top, presenting when combined with their great height, a striking appearance. The walls are invested with a crust which is of great hardness, and has been considered by Winkelman and others as a peculiar kind of plaster; but this seems overthrown by the observation of other authors, that the thickness of it diminishes regularly to the top of the chamber, and that it has actually a true stucco under it, * indicating that this crust was deposited by the water once artificially collected in this reservoir. It resembles, besides, the incrustation found in the chambers called the "Sette Sale" in the Baths of Titus at Rome, which is so hard that I found a difficulty in breaking it with a small hammer, and which is the undoubted deposition of water. The following are the constituent parts of the coating of the Piscina Mirabile:

Muriate of lime, - - -	5
Muriate of soda, - - -	11
Carbonate of lime, - - -	75
Alumina, - - - -	5
Iron and silica, - - -	3
Loss, - - -	1
	100

From the Piscina Mirabile † we command a view of the Mare Morto, which appears anciently to have constituted the famous Port of Misenum. From its shores rise the swelling plains which form the mythological representation of the Elysian fields; and, however they may fall short of what a poetic imagination might desire, they must still be dear to the classical traveller, from their intimate associations with the exquisite description of Virgil:

* Orloff, *Memoires sur Naples*, v. 350.

† I ought not to omit entirely the mention of some singular excavated apartments in this neighbourhood, called the Cento Camerelle, dug out of tufa and plastered. They have created much antiquarian discussion, and, as they do not present any peculiar physical fact, my limits do not allow me to give an account of them. They were probably prisons.

" Devenêre locos lætos, et amœna vireta
Fortunatorum nemorum, sedesque beatas.
Largior hic campos æther, et lumine vestit
Purpureo ; solemque suum, sua sidera nôrunt."

En. vi. 638.

The citation of this passage not only illustrates a classical locality, but enables me to make a remark, which I believe is new, upon a physical fact. The " lumen purpureus" of Virgil has generally been considered as a poetical fiction, and the variorum commentators have considered it merely as an emblem of beauty and purity. I have, however, had occasion to observe in the evening sky at Naples the most exquisitely purpurean tinge, not like the red glow of our sunsets, but pale and intimately invested in the colour of a sky of perfect purity, such as can never be seen in northern climates. The cause too is capable of the most perfectly philosophic explanation. The azure of the sky is imputable to the resistance of the atmosphere to the rays of light, by which the red rays, moving with most momentum, pass entirely through, while the blue are absorbed and reflected by the dense medium. The red tints of sunset and sunrise are owing to the accumulation of the atmospheric strata through which the rays must pass, by which not even those having the greatest momentum can escape; hence also the red light observed by divers under water. But the purple tinge which I observed at Naples even near the zenith, had no affinity with this cause. The atmosphere possessing there a surpassing purity, a portion of the blue rays having a free passage, escaped, and a part of the violet, which have least momentum of any, even found their way to the eye, thus producing a tinge which Virgil, himself an admirable observer of nature, transferred to his Elysian skies as a testimony of such habitual purity as was rarely to be observed even under the genial climate of Italy. We may therefore justify the poet even to the letter, and refute the observation of one, who, though no philosopher, was disposed to view things under the colouring of a warm and classical imagination, that, " in the splendour of a Neapolitan firmament, we may seek in vain for that *purple light* so delightful to our boyish fancy." *

* Eustace.

ART. X.—*Notice of the performance of Steam-Engines in Cornwall for July, August, and September* 1829. By W. J. HENWOOD, F. G. S., Member of the Royal Geological Society of Cornwall. Communicated by the Author.

Reciprocating Engines drawing Water.

Mines.	Diameter of cylinder in inch.	Length of stroke in cylinder in feet.	Length of stroke in the pump in feet.	Load in lbs. per sq. in. of area of piston.	No. of strokes per minute.	Millions of lbs. weight lifted 1 foot high by the consumption of 1 bush. of coal.
Stray Park, -	64	7,75	5,25	7,8	4,	24,7
Huel Vor, -	63*	7,25	5,75	17,5	5,4	26,
	53	9,	7,5	19,5	5,3	42,
	48	7,	5,	8,	4,9	30,8
	80	10,	7,5	13,5	5,9	56,9
	45	6,75	5,5	13,7	6,	50,7
Poladras Downs,	70	10,	7,5	9,4	6,3	56,6
Huel Reeth,	36	7,5	7,5	15,3	4,2	26,2
Balnoon, -	30	8,	7,	9,	3,4	24,7
Huel Towan, -	80	10,	8,	10,5	6,3	73,6
	80	10,	8,	6,3	4,	58,9
United Hills, -	58	8,25	6,5	6,9	4,3	37,6
Huel Sperris, -	70	10,33	7,75	6,7	5,1	43,
Huel Deer-park,	16	4,25	4,25	29,9	7,1	16,6
Huel Prosper, -	53	7,	7,	3,1	4,	19,2
Crinis, -	56	6,75	6,75	9,5	5,3	39,5
Huel Unity, -	52	6,66	5,75	9,1	7,	26,9
	60	7,25	5,75	11,7	5,7	36,2
Poldice, -	90	10,	7,	10,3	5,4	47,4
	60	9,5	6,25	12,8	5,9	37,4
Huel Damsel, -	42†	7,5	5,75	20,	4,7	32,6
	50	9,	7,	8,2	3,	136,6
Ting Tang, -	63	8,	6,	14,	4,7	46,3
	66	9,	7,5	10,9	2,9	42,9
Cardrew Downs,	66	8,75	7,	10,4	6,1	53,6
Huel Mont	50	9,	7,	10,8	4,2	32,9

Mines.	Diameter of cylinder in inch.	Length of stroke in cylinder in feet.	Length of stroke in the pump in feet.	Load in lbs. per sq. in. of area of piston.	No. of strokes per minute.	Millions of lbs. weight lifted 1 foot high by the consumption of 1 bush. of coal.
Dolcoath, -	76	9,	7,5	11,8	5,2	42,5
Great Work, -	60	9,	7,	10,2	6,9	43,8
Huel Penrose,	36	8,5	6,5	11,9	6,8	32,
Huel Caroline,	30	7,	6,	21,6	9,1	28,8
	53,5	8,33	7,	7,6	6,2	23,3
St. Ives Consols,	36	7,	7,	16,4	6,3	29,4
Lelant Consols,	15	7,5	4,5	17,2	2,9	13,6
Binner Downs,	70	1 ,	7,5	11,1	7,7	61,9
	63	9,	7,5	8,	10,	37,
	42	9,	7,5	13,5	7,1	43,7
ConsolidatedMines,	90	10,	7,5	8,8	5,3	60,7
	70	10,	7,5	9,7	6,2	60,5
	65	9,	7,5	15,	3,7	52,
	90	10,	7,5	8,3	7,	59,5
	90	10,	7,5	10,3	2,4	35,7
	65	9,	7,5	12,4	4,5	58,8
United Mines,	90	9,	8,	7,9	4,1	44,1
	30	9,	7,5	12,9	7,7	43,9
Huel Beauchamp,	36	7,75	6,	11,6	4,4	33,
Huel Rose, -	60	9,	7,	13,6	5,6	59,5
Pembroke, -	80	9,75	7,25	11,7	3,6	49,9
	50	9,	7,	11,2	6,4	43,8
East Crinnis, -	60	5,5	5,5	8,5	3,9	25,4
	70	10,	7,	9,1	4,7	36,7
Huel Hope, -	60	9,	8,	12,	5,1	59,1
Tolgus, -	70	10,	7,5	8,2	4,3	55,7
Tresavean, -	60	9,	7,	6,3	4,2	22,7
Huel Falmouth,	58	8,75	6,5	3,7	5,2	25,3

Average duty of reciprocating engines 40,8 millions of lbs. weight lifted one foot high by the consumption of one bushel of coal.

Watt's rotatory double engines employed to move machinery for bruising tin ores.

			Length of crank.			
Huel Vor,	24.	6.	3.	12.	15.5	19.1
	27.	5.	2.5	12.	17.3	21.4
	16.5	5.	2.5	8.5	25.9	12.8

Average duty of rotatory engines, 17.8 millions.

* Watt's double engines.

† Trevithick's high pressure combined with Watt's single.

ART. XI.—*Researches on the structure of Metals, as indicated by their Acoustic properties.** By M. FELIX SAVART.

HITHERTO melted metals have been regarded as the solid substances which approached most to the condition of homogeneity. They have been regarded as assemblages of an infinite number of small crystals united together without order, and as it were by chance, and it was never even conjectured that in any mass of metal there could be differences of elasticity and cohesion as great, and perhaps greater, than those which are observed in a fibrous body like wood.

Experience nevertheless shows, that circular plates of metal, of equal thickness, melted in moulds, or cut in great masses, or taken in thin plates, always comport themselves as if they had belonged to a fibrous body, or to one regularly crystallized. Thus, if we seek to make them produce the mode of division which consists of two lines, crossing each other at right angles, we shall soon discover that their intimate structure is not the same in all directions; for this mode of division cannot establish itself in two determinate positions, and almost always under the form of hyperbolic curves, which are accompanied with sounds more or less remote from each other, sometimes by a quantity almost imperceptible, and sometimes by a third, a fourth, and even a fifth. Plates of gold, silver, copper, zinc, cast-iron, forged or laminated iron, tin, lead, bismuth, steel, antimony, and a great number of alloys of these different substances, such as brass, bell-metal, &c. appeared to

* Translated and partly abridged from the *Annales de Chimie*, May 1829.

present phenomena quite analogous to those of plates of wood, or of rock-crystal differently inclined to their axes of elasticity or their directions of cleavage.

As these experiments have been repeated frequently, and under different circumstances, we may consider it as certain that a plate of metal always comports itself as if it belonged to a crystallized system ;—but does it follow from this property that metals are regularly crystallized? This difficulty may be solved by the same means by which it has been discovered. As the distinctive character indeed of crystallized bodies consists in this, that their structure is found exactly the same in every part of the same plane, and for parallel planes taken in any direction whatever in relation to the faces of the crystals, it is clear that in order to recognize if a body is regularly crystallized, it is sufficient—

1. To cut different circular plates of the same diameter and the same thickness, taken in the same plane, and to see if their modes of division are parallel to one another, and emit the same sounds.

2. To take several parallel plates, and to see if their modes of division correspond, and are accompanied with the same sounds. I therefore cut out of a cylinder of lead which weighed 15 kilogrammes, several plates of the same size. The 1st, 3d, 5th, 7th, and 9th, were perpendicular to the axis of the cylinders; and the 2d, 4th, 6th, and 8th, taken between the preceding ones, passed through the axis, and were contained in the same plane. These being examined, I found, 1. that the modes of division of the last set of plates were far from being the same, and from being accompanied with the same sounds. 2. That the modes of division of the first set of plates were also very different, and were not accompanied with the same sounds. As this experiment was often repeated, and with tin as well as lead, with the same results, we may conclude, that a mass of metal, considered as a whole, does not possess the properties of a crystallized body, though each of the plates cut from it vibrate as if they belonged to a body of this kind.

If we examine the modes of division of a circular plate of metal, one or two decimetres in diameter, and afterwards

divide it into several smaller plates also circular, we shall find that these last differ more or less from one another in their sounds and mode of division, and that the nodal lines of the one are rarely parallel to those of the other.

These and many other facts show distinctly that the metals do not possess a homogeneous structure, but only that they are not regularly crystallized. We have, therefore, only one supposition left, viz. that they possess a semi-regular structure, as if, at the moment of solidification, there were formed in their interior several distinct crystals of a considerable size, but whose homologous faces were not turned towards the same points of space. In this view the metals would resemble certain grouped crystals, each of which, considered individually, presents a regular structure, whilst the entire mass is quite confused.

This view of the matter is supported by several circumstances which accompany the solidification of metals. If we examine, for example, the surface of a mass of lead about to become solid, we shall perceive in some parts small rectilineal grooves, which are sometimes several centimetres long, which have no fixed direction, but which are crossed by a great number of other grooves of the same kind but much shorter, so that the whole surface of the metal seems to be entirely covered with this singular net-work, which evidently indicates a sort of regularity in the arrangement of the subjacent parts. If we operate, indeed, with a mass of lead of from twelve to fifteen kilogrammes, and if at the instant when the solid crust is about five or six millimetres (1–4th or 1–5th of an inch) thick, we pierce it with a red hot iron, and invert the vessel suddenly, so as to discharge the part of the lead that is still fluid, the inner face of the solid crust will exhibit a number of small octaedral crystals arranged in parallel lines, and crossing one another at right angles, which form a great number of distinct systems, corresponding in position to the small grooves on the opposite surface of the crust.

Examined with the microscope the small crystals which compose each of these systems, appear to be grouped round three lines at right angles to each other, and they are arranged so that th[illegible] are parallel to each other; and hence, they

touch only by their solid angles. If we suppose that the three right lines of each system have a direction that has no relation to the similar lines of adjacent systems, we shall have a sufficiently correct idea of the semi-regular crystallization of a mass of lead. Analogous results were obtained with copper, tin, and zinc; but the crystalline systems are more extended when the metals have been kept in fusion for a long time, and when they have been melted at different times.

It is a natural consequence of this structure, that the differences of elasticity of the same substance, appear in general to be greater in proportion to the smallness of the diameter of the circular plates employed to show them; for the number of crystalline systems which these plates contain, will be less numerous as their diameters are less considerable. This is actually the case. The interval between the two sounds of a plate of lead, tin, or zinc, from twelve to fifteen centimetres in diameter, is seldom more than a semi-tone; while this interval is frequently a fourth in plates of the same substances, when their diameters do not exceed three or four centimetres. For the same reason, a mass of metal examined by the same process, will appear in general to possess a regular structure in proportion to the smallness of its dimensions.

Although it appears to be sufficiently established, that fused metals are an assemblage of crystals arranged regularly, and disposed in systems distant and differently inclined to each other, yet it remains to be determined, how this arrangement can give to these substances, properties analogous to those which are observed in crystallized bodies; but, though this inquiry is a difficult one, I shall endeavour to give an idea of the progress I have made in it.

Let us take two circular plates of wood of equal thickness, containing in their plane the axes of greatest and least elasticity, and let us glue them together, so that the axes of the same kind may form an angle more or less considerable; then it is obvious, that this system of crossed plates will give an idea of what takes place in metals. The progress of the phenomenon is then very simple, for the modes of division are very nearly the same as in each of the plates taken separately, that is, that one of the two is composed of two lines at right angles, and

the other of two branches of a hyperbola; but with this peculiarity, that one of the nodal lines of the rectangular system is always placed on the line which bisects the angle which the fibres of wood form with each other, and that one of the asymptotes of the hyperbolic curve appears to be sensibly parallel to the direction of the fibres of one of the plates, while the second is parallel to the fibres of the other plate. We shall obtain perfectly analogous results, by crossing any two plates which contain at least one of the axes of elasticity, that is, in which one of the nodal systems are formed by two lines at right angles to each other. If one of the two plates does contain any of the axes in its plane, then the nodal systems are composed only of branches of a hyperbola, and the position which they take is intermediate to that which they affect in each of the plates considered separately. We may therefore conclude, that, in whatever manner bodies which possess these rectangular and unequal axes of elasticity are united together, their effect when combined, is to exhibit all their axes of elasticity.

In general there does not appear to be a great difference between the structure of plates of metal which have been cut out of great masses, and that of plates of the same substance which have been melted in moulds to give them the circular form. Among both these are found some in which the interval between the two sounds is only very small, while in others it embraces several tones. In the plates formed in moulds it is remarkable, that the substance of the mould, the position of the jet at the circumference or at the centre, the direction of the mould, whether vertical, horizontal, or inclined, do not appear to have any influence over their state of elasticity; that is, we find always a direction of the greatest resistance to flexion, as well as the two modes of division affecting determinate positions and accompanied by different sounds.

It does not appear that a sudden cooling, nor an electric current which traverses the plate in one of its diametral lines while the metal is in fusion, exercise any appreciable influence over the general character of the phenomenon; but it is otherwise with a series of small blows given to the mould whilst the metal is solid, as this last action almost never fails

to disturb the formation of the crystalline systems, and to determine an uniformity of elasticity sufficiently great to cause the plates which have undergone this change to emit only one sound, and to have its nodal system composed of two lines occupying no longer a determinate position. It would be both curious and important to examine if the metals whose crystallization has been thus disturbed are as tenacious as in the opposite case, and to see if they do not acquire some new properties which will facilitate their application to certain operations in the arts.

Several causes, such as hammering, rolling, and annealing, may alter in different degrees the distribution of elasticity in metals, but none of these causes appear to be of a kind to bring these substances into a state of homogeneity. The circular discs of lead, copper, tin, brass, diminished to three quarters of their thickness by means of hammering, appear to preserve very nearly the same properties which they had when they were newly melted: Their different nodal systems had only a slight change of aspect and of place, but the sounds which accompanied them were still sensibly at the same distance from one another.

The process of rolling appears to produce analogous effects, but with this difference, that the crystalline systems being considerably elongated by this action in two directions perpendicular to each other, it may happen that plates of great extent present a structure approaching much nearer to regularity. I may mention, for example, a plate of zinc seven or eight decimetres long, and three or four broad, out of which I cut ten or twelve circular discs of the same diameter, which affected the same modes of division similarly directed in relation to the sides of the plate, and accompanied with the same sounds, so that we may suppose that the whole of this plate of metal was crystallized regularly throughout its whole extent.

The interval between the two sounds of each of its circular plates was a semitone minor. One of the modes of division was composed of two lines at right angles, and the other of two branches of a hyperbola to which the preceding lines were axes: In short, they comported themselves as if they had belonged to a body having three rectangular and unequal axes

of elasticity, of which one of the axes was in the plane of the plates.

From these researches it follows, that the differences of resistance to flexion in different directions of the same mass of metal may be much greater than in certain woods, such as oak, beech, &c. since we meet with circular plates of metal whose two sounds differ a fifth, and that in the woods which we have mentioned the interval between the two sounds does not exceed a third minor for directions where the differences of elasticity are the greatest; and yet, as we have formerly established, the extreme elasticities are as 1 to 16.

The influence of annealing appears to be very feeble or perhaps nothing when the metals have not been hammered; for several discs of copper which had been exposed during several hours to near their melting heat still emitted the same sounds which they had produced before this operation. But it is not so when the plates have been previously hammered, and then re-heated, for it often happens that the interval between the two sounds varies a little, and that there is some change in the disposition of the nodal lines.

The phenomena which we have observed in metals are far from being peculiar to them. Analogous ones occur in glass, sulphur, common resin, copal, amber, plaster, slates, &c. The interval between the two sounds of different plates of these substances is always very small. It rarely exceeds a semitone major, and the two modes of division, though they constantly affect a fixed position, differ so little from one another that they always appear in the form of nodal rectangular lines. Among the bodies which I have examined, Spanish wax is the only case in which the system of two nodal rectangular lines may be found indifferently in all directions; but this substance being a simple mixture of lac, turpentine, and cinnabar, we may conceive that the last ingredient, which is in a pulverulent state, prevents the particles of the resin from taking a regular arrangement

I shall conclude this memoir with an observation applicable to all bodies which do not crystallize regularly: Immediately after they become solid they in general sound with much less facility than they do in some hours, some days, or even some

months after. It often happens that a body which at first produces only sounds dull and difficult to obtain, ends by vibrating with such facility and energy that it bursts in pieces with the slightest agitation. Hence it seems to follow, that, in the act of solidification, many of the particles were caught and fixed in positions which they afterwards tend to abandon, and that they do not attain a state of equilibrium till after a long time. If, for example, we form in a mould a circular disc of sulphur, and try to make it sound immediately after it is cold, we shall not succeed; but at the end of some days we may elicit from it some dull sounds; if we then determine the number of vibrations obtained by any mode of division, and then lay the disc by for one or two months, we shall find that it will sound with extreme facility, and that the number of vibrations is much greater, the sound being raised more than a tone. It is well known that sulphur which has been melted does not recover when it is solid the properties which it previously possessed, but it was never conjectured that entire months, and perhaps even a longer period, was necessary for this purpose.

ART. XII.—*On the Effects of the action of Cold on Animals, as exhibited in their Hybernation and Lethargy.* By M. FLOURENS, Member of the Academy of Sciences.*

EVERY person is aware of the important function which is performed in the economy of the universe by the unequal distribution of heat. It is this which determines climates; it is upon this that the seasons depend; and it is from this that climates and seasons derive that infinite variety of animal and vegetable productions by which they are characterized.

In order that an animal or a vegetable may live,—in order that either of them may grow and reproduce,—a certain degree of temperature is necessary; and this temperature varies for each species of plant or animal, so that, in passing from one place to another, we have a new temperature, consequently a

* Read at the public sitting of the Academy on the 15th June 1829, and translated from the *Revue Encyclopédique*, September 1829, p. 537-551.

new climate, and also new animal and vegetable productions. Even in the same climate the changes of temperature which return with the seasons, bring along with them similar changes in plants and animals; and in the same climate, in the same season, the different regions of the atmosphere have each a peculiar temperature, and each has also its own animals and vegetables.

It is on these great relations between the productions of climates and the seasons, and between climates and seasons and their temperature, that a celebrated traveller, M. de Humboldt, has founded the *Laws of the Geographic distribution of Plants and Animals*; and similar relations evince beyond a doubt the extensive influence which temperature exercises over life and organization.

But, as will be proved by the following experiments, it is not only on organization and life, taken collectively, that cold exerts an influence. It acts upon each organ and upon each function. It produces in each of these organs or of these functions a specific effect; and it is for the purpose of determining some of these effects upon animals that the following experiments were undertaken.

One of the most remarkable effects of cold, and that of which I shall first treat, is *Hybernation*.

The name *Hybernation* is given to that species of torpidity or lethargy in which some of the mammalia of our climates, like the marmot for example, pass the season of cold.

If we conceive to ourselves animals that have become cold, senseless, immoveable, rolled up into a ball, spending from three to four months in succession without eating, drinking, breathing, and with their circulation almost extinct,—if we then consider that the animals subject to hybernation differ in no respect, at least in nothing sufficient to account for the singularity of the effects produced, from other animals very near to them and not subject to hybernation;—that, beside the dormouse (*Myoxus glis*, Desm.) the garden dormouse (*M. nitela*,) and the common dormouse (*M. avellanarius*,) &c. which hybernate, are found the rat, the mouse, the squirrel, and twenty animals of the same kind which do not hybernate;—that, on the other hand, hybernating animals occur indiscriminately in the most diff[illegible]ilies in the insectivorous tribe, as the hedge-

hog and the bat; in the *Rodentia*, as the dormouse, hamster, marmot; if we, in short, consider that while in our climates it is during winter that animals become lethargic,—in the torrid zone, which has also its sleeping animal, the *tenrec*, it is only during the greatest heat that it sleeps; if we consider all these points, we shall have but a faint idea of the curious details, the singular effects, and the difficulties almost insolvable, of this extraordinary phenomenon.

A phenomenon like this, of so high an interest, might naturally have been expected to arrest the attention of physiologists, and the mechanism of it being so obscure, it ought particularly to have been the subject of their speculations. The ancients, who explained much and observed little, have left us on this subject, as on so many others, merely words; and, as Fontenelle remarks, these words "have no other merit but that of having been long mistaken for things."

The two first naturalists that studied this subject were Haller and Spallanzani; but it was particularly about the beginning of the present century that the Academy of Sciences, having made this great phenomenon the subject of a double prize, the emulation of philosophers speedily collected from all quarters an infinite number of valuable facts and observations, and that there appeared in Germany the works of MM. Herold and Kafn, in Italy that of M. Mangili,* and in France those of MM. Saissy, Prunelle, &c. The following experiments, which may be regarded as a continuation of them, were made in the south of France on the *lerot* or garden Dormouse, (*M. nitela*, Desm.) an animal of the size of a rat, with a grey fur on the back, white under the belly, having its eyes encircled with a black band, and its tail tufted at the extremity.

The *lerot* lives on fruits. It is particularly fond of fishes, pears, apricots, &c. which allure it into our gardens, and even into our houses. In winter it retires into holes, where it hybernates, and where we often find several lying beside and

* An abstract of Mangili's observations, and of the labours of English as well as of foreign naturalists, will be found in the copious and valuable article on HYBERNATION, by the Rev. Dr Fleming, in the *Edinburgh Encyclopædia*, vol. xi. p. 385-405.—Ed.

above one another, as if for the purpose of keeping up and prolonging their heat.

In this brief account of my observations on lethargy, I shall only allude generally to the state and the external condition of the hybernating animal, two points in which preceding authors have left little to be done, and I shall hasten to the consideration of their internal or organic conditions,—a point which will probably long constitute the true difficulty of the subject. I shall begin therefore with the examination of the state of the animal, and of its manner of awakening.

During lethargy the animal has an orbicular and regularly bent position, the mouth being applied under the belly, the hind feet being brought forward, and the fore-paws bent against the breast, the ears lying on the sides of the head, the eyes firmly closed, and the whole body collected into a ball, with the tail rolled quite round the body.

In this state the animal is cold. We may touch it gently without its moving, but it moves if we pinch it strongly. If the irritation continues, it awakes; and what will give us an idea of the singularity of the state from which it emerges, is the difficulty with which it experiences in awakening. It begins by opening its mouth violently, and keeps it a long time open. Its sides then heave, the thorax at first remaining immoveable; the thorax then partakes in the motion of the sides, and the respiration commences. The animal cries, and has the appearance of being choked. Its whole body trembles; it opens its eyes; but it does not at first see. At last the waking takes place; it sees, hears, and recovers by degrees its heat and its motions.

There are two distinct degrees of lethargy; in one, viz. *imperfect lethargy* we see the respiration suspended, and gradually resumed, every three, four, or five minutes, for example. In the other, or perfect lethargy, the respiration is on the contrary completely extinguished, and I have often seen this extinction continue for whole hours during the continuance of my observation.

In imitation of Spallanzani, I submitted several torpid animals to the action of different mephitic gases, and though I did not obtain exactly the same results as he did, it follows

from my experiments and his, that the total suspension of respiration is a phenomenon as incontestible as it is curious.

The circulation is nearly in the same state as the respiration. At first there is no pulse in the arteries of the limbs. If we open a vein or an artery, there is either discharged no blood at all, or only a few drops of a blackish blood. If we touch the heart we feel only occasional and uncertain movements.

It is known that animals have the power of producing a certain degree of heat which constitutes their proper temperature, and that this temperature is nearly 38° Centigrade (100°.4 Fahr.) among the Mammalia, and varies very little in them, at least within the limits of the temperature which corresponds to different regions of the globe.

Among the hybernating Mammalia, the animal heat is also 38° in the waking state, but in the lethargic state falls quite suddenly to 5°, (41° Fahr.) 4°, (39° Fahr.) or even 3°, (37° Fahr.); and next to the almost complete extinction of circulation and respiration, nothing is more astonishing than the variations of this animal heat, whose uniformity and regularity appears to be one of the most general laws of the entire class to which these animals belong.

I come now to the external conditions of lethargy.

Cold is, at least in our climates, the first of these conditions. While the warm season, indeed, lasts, these animals do not become lethargic; when the cold season begins, then lethargy commences.

During their lethargy, too, we see them alternately torpid or awake, according as the temperature sinks or rises; and it is not the rise of temperature only which awakes them. A sudden diminution of temperature, which, if it had found them awake, would have made them torpid, awakes them when it finds them torpid.

It requires, therefore, a certain and constant degree of cold, in order that lethargy be produced and maintained. Next to cold, the most favourable condition is rest, or a freedom from excitation, and, if we consider the faculty of the animal to produce heat, and also, that it is chiefly by motion that it is produced, we shall then see that these two conditions, viz. the

want of excitation, act in nearly the same manner, the first by diminishing the external heat, and the second, by preventing the internal heat from developing itself.

It has been said that light and the presence of food are hostile to lethargy, but, according to my experiments on the *lerot*, these causes have little or no influence.

I now come to the internal or organic conditions; and it is important to determine *first*, on what organ, or particular organic modification, lethargy depends; and *secondly*, what is the mechanism of this phenomenon.

On both these points, however, we possess only conjectures, and, with respect to the first, there is scarcely an organ to which these conjectures have not been successively applied.

The two organs which have been particularly selected, are the *encephalon* and the *thymus*;—the *encephalon*, to which physiologists have long been in the habit of referring what they could not otherwise explain; and the *thymus*, a glandular body, situated in the front of the neck, and penetrating to the heart, and to which the mode of its developement gives a particular claim to perform the principal part in lethargy.

This organ, indeed, is in the highest degree of enlargement at the moment when the animal falls asleep. It collapses at the time when it awakes, and amongst the mammalia it disappears almost entirely at the adult age, and is only developed in the fœtus, the state of which, in the womb of the mother, approximates it by so many points to the state of the torpid animal.

These two conjectures will deserve to be submitted to experiment, particularly in the present day, when the experimental method has localized so many other phenomena, and when, to speak only of my own experiments on the encephalon, it has succeeded in determining a distinct organ for the sensations, an organ for the movements of locomotion, an organ for the motions of reproduction, and has even found a point to which it is sufficient for any part to be attached to live, and from which it is sufficient that it be detached to die, and which thus constitutes the central and vital part of the animal economy.

I therefore suppressed, in succession, the different parts of the enc[illegible] in different *lerots*. The suppression of some

of them prevented the animal from falling under lethargy, and the suppression of others appeared even to hasten it.

The result was similar for the thymus, and its suppression rather accelerated than retarded the action of lethargy. I have, besides, constantly observed, that whatever debilitates the animal has the same effects upon it as these suppressions. Among my *lerots* the youngest and weakest always require a less degree of cold than adults in order to become torpid.

These experiments show that it is neither in the encephalon nor in the thymus, that the principle which determines lethargy resides. Those which follow seem to show what is the mechanism of this phenomenon.

The carotids having been laid bare in a lethargic *lerot*, by an operation which might be supposed to be painful, but which the animal scarcely feels, I found that they did not beat even after the operation more than nine or ten pulsations in a minute. Some time afterwards, striving more and more to awake, and the respiration renewing itself, they beat 20, then 30, then 45, then 100, and lastly 110 pulsations in a minute, when the respiration was perfectly re-established.

The *lerot* being then exposed to the action of cold, I observed its respiration grow weaker and weaker by degrees, and its carotids at first beat 100, then 65, then 50, then 30, then 20, and finally 8 or 9 pulsations per minute, when the pulsations were again quite extinguished, and the animal quite lethargic.

It was now interesting to determine if the artificial suspension of respiration would not bring about the same results as that which had brought about lethargy.

The respiration was now artificially suspended in a *lerot* awake; the blood of the carotids soon became black, and the number of pulsations more and more reduced. At the fourth minute there were only thirty-two; half an hour later there were no more. The heart alone beat 8 or 9 pulsations, which was precisely the number which I had found it to beat in the preceding *lerot* in perfect lethargy. By suspending the respiration in this experiment, I had reproduced the state of circulation in lethargy, or more exactly, I had reproduced the le-

thargy itself, for the state of rest in the animal economy always corresponds to the state of the circulation.

Respiration was then successively suspended in different *lerots* more and more profoundly lethargic, and the following were the results. In all of them the circulation survives the respiration;—in all, the time was as much longer as the lethargy was profound, and the external temperature nearer the temperature proper to the lethargic state. I at last succeeded by a suspension of respiration, successively interrupted and resumed, to render the animal lethargic under degrees of cold less than those which it would have required to become so with a free respiration.

Every thing then proves that it is by respiration and by means of the modifications which it impresses on this function, that cold acts in lethargy.

I now pass to another class of experiments, and to the curious results which were obtained, and hasten to add some conclusions of more immediate utility.

In May 1826, when I was in the country, there was brought to me a young duck of a brood newly hatched, which was on the point of being suffocated. It opened its mouth wide, breathed with extreme difficulty, and died at the end of an hour or two.

The examination of its organs exhibited the lungs of a deep red and gorged with blood. The animal had died of a violent inflammation of the lungs.

I repaired to the spot where the ducks were, and I was soon shown a second, which was about to sink under suffocation like the first, and while I was examining it, a third was suddenly seized before my eyes, with an oppression of the breath so violent, that at the moment it was attacked the animal became motionless, opened its mouth wide, breathed with extreme difficulty, neither ate nor drank, and died at the end of two or three hours.

The one which I had found suffocating on my arrival also died some hours after the attack. Both of them exhibited the same inflammatory fullness of the lungs which I had observed in the first. It was under the same kind of acute pneumony that both of them had died, and it was besides evident, upon

considering the low temperature, and the northern exposure of the place where they were, that it was the cold alone which had produced these pulmonary inflammations.

This violent effect of cold upon young birds recalled to me what I had observed some years before in several animals subjected to different experiments.

These animals operated upon during the fine season, but completely cured of their wounds, though weakened, almost all died of chronic pulmonary inflammations during the first cold weather that followed.

The approximation of these effects of cold upon different animals, its action so determinate and so constant upon the respiratory organ, the different degrees of chronic or acute inflammation which were produced under my own eyes, made me feel that I had at last in my hands a direct method of investigating pulmonary consumption, one of the most cruel maladies which afflict humanity.

I was at first desirous of determining if, in certain given cases, cold alone was sufficient to determine pulmonary phthisis I was then anxious to know, if in those same cases it was sufficient to avoid cold in order to avoid this disease; and finally, I was anxious to see if this malady, begun under the influence of a cold temperature, could not be cured by the sole effect of a mild temperature.

It cannot be expected that I should here give an account of all the experiments which I made on these three points; but in order to give an idea of the manner in which they were pursued, and of the results to which they led, I shall briefly relate the circumstances of one of them.

In the beginning of October 1826, I procured a brood of twenty-three chickens about a month old, When the first cold weather came on, I put six of them in a place in which I kept up a mild and regular temperature. None of these six were affected with pulmonary consumption.

Of the eleven chickens which I left exposed in the stable-yard to the variations of the atmospherical temperature, all except two died of pulmonary phthisis, after having passed through all the stages of debility and consumption, and the two surviving ones always remained small and weak.

There remained six chickens out of the twenty-three, which gave me the most important results.

I left them at first in the common yard till they gave evident indications of phthisis more or less advanced. I then took them to the mild and constant temperature where I had placed the six already mentioned. Two of them, which certainly would have died in the first or second day afterwards if I had left them in the cold, after having made a slight recovery, perished, one at the end of five, and the other at the end of nine days. I found their lungs in a state of complete suppuration and inflammation.

The other four resumed by degrees their vivacity and strength; they recovered completely; and in April 1827, when I gave them all their liberty, they were as well as those which had never quitted the warm temperature.

It remained only to be seen what was the actual state of the lungs of these four chickens, and what was the state through which they had passed during the evident signs of phthisis which they had exhibited.

I found in the lungs of them all traces of former changes, more or less deep, but still cured.

One of these healed lungs preserved in spirits I have shown to the Academy, and one of the lobes presents only sunk depressed vesicles, cicatrized inflammations, and extinct suppurations,—a testimony no less authentic than consoling of the complete cure of a disease which, from the number of victims which it carries off, renews every day the sorrows of domestic life.

This last experiment shows clearly what is the kind of influence which warm climate exercises over pulmonary consumption; and it is in promoting the cicatrization of the lungs affected by the cold of our climate, that the genial temperatures of the South produce the good effect which physicians have long observed.

From these observations it will be seen how far the influence of temperature, or more particularly that of cold, extends both over the animal economy in general, and over the respiratory organs in particular.

We see also how much advantage may be derived in the

illustration of human pathology from the study of the diseases of animals; and how wrong it is to neglect or despise them.

The experiments which we have described show that we may form, as it were, morbid phenomena of all kinds, and at pleasure, and that we may stop them when we please after they are formed.

We may therefore excite and develope in animals the different maladies which are observed in man, and, what we cannot do upon him, we can study them upon them in all their actions, in all their phases, and in all their degrees, under the comparative action of medicines the most violent and the most diversified.

Buffon has said *that if animals did not exist the nature of man would have been still more incomprehensible.* This is particularly true of the nature of his diseases, and it would no doubt be worthy of a nation which has set the first example of so many other useful institutions, to set also that of a similar and truly experimental study of the evils which afflict humanity. It would be worthy of her thus to realize the wish of a great physician,—of Baglivi, who, in the 17th century, proposed establishments in which the diseases of animals might be studied with the view of illustrating and bringing to perfection the study of the diseases of man. In order to form an idea of what may yet be done in medicine by experiments on animals, we have only to look at what has already been done in physiology.

Is it not from the experiments of Harvey, Hunter, Haller, Reaumur, Spallanzani, and Bichat, that there has arisen all those discoveries, not less admirable than unexpected, of the circulation of the blood, the course of the lymph, the property of the nerves to transmit sensibility, the property of the muscles to contract, the action of the gastric fluids in digestion, and the opposite qualities of the red and the black blood, &c. I do not speak of twenty discoveries made in our own days; for it is well known that a discovery in order to be admired must be old, and to have, as Father Malebranche expressed it, a venerable beard.

Every thing should make us hope that the ideas which we have stated respecting the progress which human medicine

may expect from experiments made on animals will not be disdained in our days; for nobody is now ignorant that every thing depends upon another in the living economy, diseases —functions, and organs;—that we cannot act upon diseases but by functions,—upon functions but by organs; and that thus therapeutics is founded upon pathology—pathology on physiology, and physiology upon anatomy.

ART. XIII.—*Account of the Siamese Twins, united by a cartilaginous band.* With a Figure. See Plate II.

AMONG the aberrations from the general laws which regulate the structure of man, there has perhaps never occurred an example so singularly interesting as that of the Siamese youths who are now exhibiting in London.

The repetition of particular organs which constitute the general character of monstrous productions never fails to make a disagreeable impression on ordinary spectators; and in the cases which have hitherto occurred of the duplication of the whole frame, the circumstances have been such as to excite a similar feeling. In the present case, however, the union of two living beings is presented to us under the most interesting circumstances; and we are persuaded that the general reader, as well as the physiologist, will peruse with pleasure the accounts which have already appeared of this extraordinary phenomenon.

The Siamese twins are two distinct and perfectly formed youths, about 18 years of age, possessing all the faculties and powers of that period of life, united together by a short band at the pit of the stomach. On first seeing them, their sides are so close together, that one would suppose there is no interval between them. On examining them, however, they are found not to touch each other,—the band which connects them being, at its shortest part, which is the upper and back part, about two inches long. At the lower front part this band, which is there soft and fleshy, or rather like thick soft skin, is above five inches long, and might be susceptible of extension, were it not for a thick, rope-like. cartilaginous substance, which forms the upper

part of the band, and which is not above three inches long. The band is probably two inches thick at the upper part, and above an inch at the lower part. The back part of the band, which is rounded from a sort of thickening at the places where it grows from each body, is not so long as the front part, where it is comparatively flat. The breadth or depth of the band is about four inches. It grows from the lower and centre part of the breast of each boy, being a continuation of the cartilaginous termination of the sternum, or breast-bone, accompanied by muscles and blood-vessels, and enveloped, like every other portion of the body, with skin, &c. At present this band is not very flexible; and, according to Mr Hunter, who has known the youths for six years, the cartilaginous substance of the upper part is becoming gradually harder, the change having been considerable within the last four years. The twins have only one navel, which is placed about the centre of the band, equidistant from both bodies. From the nature of the band, and the manner in which it grows from each boy, it is impossible that they should be in any other position in relation to each other, but side by side like soldiers, or coming up a little to front each other, though their natural position is that of face to face. Their arms and legs are perfectly free to move. There is no connection between them but this band, and their proximity seems in no way to incommode either. Each of them, whether standing, sitting, or moving, generally has his arm round the neck or waist of the other; and when this is the case, you observe that they are perfectly well-formed and straight. When they take the arm from this position, so close are they kept together, that their shoulders cannot be held straight; and the near shoulder of each being obliged to be held down or up to allow them room to stand, gives them the appearance of being deformed; but two straighter or more flexible bodies can scarcely be seen.

In their ordinary motions they resemble two persons waltzing, more than any thing else we know of. In a room they seem to roll about as it were, but when they walk to any distance, they proceed straight forward with a gait like other people. As they rose up or sat down, or stooped, their movements reminded us occasionally of two playful kittens with their legs round each

other. They were, though strange, not ungraceful, and without the appearance of constraint and irksomeness. The average height of their countrymen is less than that of Europeans, and they seem rather short for their age, even judging them by their own standard. They are much shorter than the ordinary run of youths in this country at 18 years of age, and are both of the same height. In personal appearance there is, indeed, such a striking resemblance between them, that, except from position, it is difficult to distinguish one from the other. In the colour of their skin,—in the form of the nose, lips, and eyes, they resemble the Chinese; but they have not that broad and flat face which is characteristic of the Mongol race. Their foreheads are higher and narrower than those of the majority of their countrymen. The expression of their countenance is cheerful and pleasing rather than otherwise, and they seem much delighted with any attention paid to them. Their appearance betokens perfect health. To their friends and attendants, and to each other, they are said to be much attached. They read the countenance of the visitor readily, and are easily affronted with any expressions of pride or contempt. They have not learnt, we believe, any manual art beyond rowing a boat, but they can run and jump, and climb rigging with great facility. They are dressed in a short loose green jacket and trowsers, the costume of their country, which is very convenient, and allows the utmost freedom of motion, but does not show the form of the boys to advantage. Almost all such deviations as this from the usual forms of nature are offensive, but there is nothing in the appearance of these boys to excite a single unpleasant emotion. With their arms twined round each other, as they bend down or move about, they look like a group of statuary.

It has been stated that they never speak to each other, but this is a mistake; though, as they appear to have a means of communication more rapid than by words, we cannot be surprised that they do not use their tongues readily. They constitute, we believe, the most remarkable specimen ever yet known, of two human bodies, perfect in all their parts, having all their animal functions separate and distinct; all the powers of locomotion, and all the faculties of each belong[illegible] himself; in short, of two separate persons

united and bound together by an inseparable link. They have thus grown up almost to manhood, and there is no reason why they may not live as long as the average duration of human life. We see nothing, even in their formation, why they should not be able to practise several of the arts of life. In their own country they are said to have caught fish, and probably thus to have supplied themselves with sufficient food. They are very strong, and were able to lift a gentleman of considerable weight with great ease. Strange as is their conformation, and helpless as they might appear, they are thus found to possess all the means of providing for themselves.

A great many curious questions arise on contemplating these youths. Those connected with the science of anatomy,—relating to the structure of the connecting band, and how it is kept alive, whether blood flows into and circulates through it from each, and passes into the system of the other, whether it be composed of bone or cartilage, whether it could be safely divided or not—though the boys, it seems, do not hear with satisfaction of a separation—with many similar curious questions, time only can solve.

Those questions connected with the minds of the two youths are perhaps of equal importance, and they can only be settled by continued observations. From the reports of Captain Coffin and his companions, the boys seem affected by the same passions, resent the same insults, and are grateful when either receives a benefit. They are affected to a certain extent, by the same pains. A short time ago one of them had a toothach, and the other was observed to be at the same time restless and uneasy; but though thus similarly affected, it is obvious that one will does not sway them both; both have a separate power of voluntary motion; but they are so accustomed to move in unison, that the slightest indication of a wish seems to operate on them both, and they move as if they had but one will. We presume this is the result altogether of habit. When they were children, according to the manners of their country and the poverty of their parents, they would be suffered to roll about on the ground, just like two young animals, and their movements being under no control, would always be as much influenced by the will of one as of the other; and the inconve-

nience of pulling contrary ways would be so continually in operation, admonishing them by the pain they suffered not to do so, that they would necessarily come to move together.

From being continually united, of course they have formed the same habits, and the same objects strike their senses at the same time. They are not, therefore, subject to many different motives. Thus they always, on the principle of habit, eat and drink at the same time, and they always go to sleep at the same time. Indeed it is said that they are so sensible on this point that one cannot be awakened without rousing the other.

When they were conveyed through the streets in a coach, their unity of action was such that they could not be prevailed upon to look out of its opposite windows. Notwithstanding these facts, the independence of their volition is certain, and was well illustrated by a recent occurrence. After rambling about the room the youths turned into the passage which leads from the entrance door of the apartment; as they approached the door, which is partly of glass, Captain Coffin called *Chang*, the name to which one of them answers. The youth instantly turned in obedience to the call, whilst his brother eagerly bent forward to gratify his curiosity by peeping through the door. Hence it was obvious that they were not governed by one will, as the inclination of one boy was to return in obedience to the summons, but he was drawn away in the opposite direction by the other in the eagerness of his curiosity.

Attempts have been made to create jealousies between them, but without the slightest effect. Any gift which they receive capable of division is shared between them; and any other description of present passes from one to the other as a common property. It would perhaps be more correct to say, that they appear to recognize no differences between themselves. A very attentive observer, however, will not fail to discover between these two boys, who certainly bear the strongest possible resemblance to each other, a marked distinction. One seems to be a little more robust than the other, and even to possess an intellectual superiority over his brother. Perhaps this notion acquires plausibility, from the circumstance that the former generally acts as the organ of communication with the interpreters. It was observed that the superior brother yielded on all occasions to

the impulses of the weaker, giving up his own choice, and preferring the course intimated by the other. The inferior brother then playfully leans against the other for his support, or the one pats the cheek, or presses the forehead, or adjusts the shirt-collar of the other, in such a way as betrays the kindliest feelings in each, and the tenderest affection for one another.

The following interesting report was drawn up by Dr Samuel L. Mitchill, and Dr Anderson of New York, and is dated September 24, 1829 :—

" In accordance with your request, we have the pleasure to communicate the observations made at our visit this day to the Siamese youths.

" We find them connected to each other by a band extending from the pit of the stomach of each, made in the following manner :—

" The xiphoid cartilage, proceeding from the lower part of their two breast-bones, is continuous, and forms a hard elastic upper edge to the band that joins these boys. This cartilaginous structure is concave at its upper part, becoming the upper boundary of a canal in the band that communicates with the abdominal cavities of both children ; from which the canal is necessarily lined by the continued membrane, and the whole is covered by common integuments or skin. The band thus constituted is from four to six inches in length, and about two in thickness, is rounded at its upper part, and sharp at its under edge, having midway at this part a cicatrix or scar, showing where was connected the single navel-string, or umbilicus, which alone nourished these two children before birth.

" Into the canal of this almost cylindrical band, there is a protrusion of viscera from the abdomen of each boy, upon every effort of coughing or other exercise ; and this protrusion may be of intestine, liver, stomach, or spleen, as either of these parts should respectively present to the openings.

" The sense of feeling on the skin of this band is connected with each boy, as far as the middle of its length from his body. And their pulse at the wrists happened this day to beat in alternation ; one of them was under a slight catarrhal fever, with cough, but it had no influence on the other.

" There can be no doubt but that if these boys were separated

by the knife, and this band cut across at any part, a large opening would be made into the belly of each, that would expose them to enormous hernial protrusions and inflammations, that would certainly prove fatal.

" We have understood the mother to have noted a very curious fact, worthy the attention of accoucheurs, that, when they were born, the head of one was covered or encased by the lower extremities of the other, and thus they made the easiest possible entrance into the world.

" They are so perfectly satisfied with their condition, that nothing renders them so unhappy as the fear of a separation by any surgical operation ; the very mention of it causes immediate weeping.

" Inded, there is good reason for this uneasiness ; for, as stated above, according to our judgment, there would be the most extreme hazard in any such attempt, and even after cut asunder, they would experience much diminution of enjoyment. But it has been urged by many that they ought to be disconnected. We think such an opinion is incorrect. It cannot, consistent with our principles and usages, be done without their consent. To this they are totally opposed ; and, as they are under the protection of a kind and benevolent gentleman, we know he will take good care of them, and if they live, return them to their homes again.

" As they are so alert and vigorous, we readily coincide, that, ' in ten seconds, they can lay a stout ordinary man on his back.' "

The following letter on the same subject has been published in the Times by Sir Anthony Carlisle, and dated November 24, 1829.

" The boys were dressed in the garments of their own country, and no parts of their persons exposed save the front aspect of the lining band which connects them together, it being placed immediately below their respective breast-bones. This joining part presents a surface of natural and healthy skin, and to the feel it seems to include an extension from each of the cartilages which terminate the breast-bones. The entire band admits four fingers to pass freely behind it, when the boys stand shoulder to shoulder, and its width and thickness allows the thumb to

meet the fingers on the front aspect. The vestiges of one common navel are visible at the lower and middle part of the band. When either of the boys was desired to cough, it became evident to the person grasping the band that a ruptural protrusion was forced into the band next the individual who coughed, and a middle shut space of more than an inch remained of these rupture sacs. These facts are of importance, because in the event of death to one of the twins the life of the remaining brother might be preserved by a prompt and skilful separation of the dead individual. The pulse of the boy on the right side was 87 beats in a minute, that of the one on the left 82; but as they had not before seen a stop watch, and were much agitated by observing its movements, it is probable that moral excitement had some influence on the frequency of their pulses. Their general aspect was alike, and their teeth of similar diameter. They were cheerful, apparently in equal good health, and evidently unaccustomed to petty restraints.

"There is nothing disgusting or even indecorous in the exhibition of these curious persons; and they do not deserve to be regarded as monsters, since their slender union is but one of many instances which happen to the whole animal creation. If indeed nature had not carefully provided against its frequency to the human race, the occasional appearance of united twins would give rise to many legal perplexities."

Art. XIV.—*Contributions to Physical Geography.*

1. *Description of the Falls of Gersuppah in North Canara.*

The following description of the falls of Gersuppah, in North Canara, appears in a letter, published in a Madras paper; they are represented to be the grandest in the world.

"The falls are situated at the distance of a mile to the west of a small village called Kodakainy, which forms the boundary of the Bilghy Talook, in North Canara, and lies contiguous to the Sagara district of Mysore, receiving a continual supply of water from twelve streams, which conjoin, as the name implies, at Bāringee, in Mysore; five of these pursue their course from Ramachendapoorah; four from Futty Pettah, or the town of

Victory, so named by Hyder; and the remaining three at Koodolee; and after being precipitated down the cataract, and then gently winding the current through a rugged way, which it has forced through the base of the mountains at the verge of their declivity, widens at Gersuppah, and forms a beautiful river, called Sarawati, navigable for sixteen miles for boats to the town of Honore, where it falls into the sea.

"Like most other places to which the natives have given names from something remarkable in their soil or site, this was called *Gersuppah*, because the ground, before the buildings had been erected, was covered with cashew-nut trees; *Ger*, signifying in Canarese, the tree of this description, and *Sooppoo*, a leaf.

"It was asserted by the bramin who accompanied me, in their usual exaggerated style, that the old city here contained, in its flourishing state, a lakh of houses, and I have no doubt, from the extent of the ruins, that its population may have been above half that number. Out of seventy-four temples called *Busty*, there remains but one, well constructed of granite, covered with a stone roof, where the *Chatour Mookee*, or four-fronted idol of the Jain caste (the then inhabitants) sits, surviving the homage of its long silent worshippers, a prey to the moles and to the bats.

"On leaving Gersuppah, we commenced the arduous undertaking of ascending the Ghauts. The pass here is neither so steep, rugged, narrow, or so much intersected with conical loose rock as those in other directions through the same range; but is much longer, being fully twelve miles in continued undulations, so that the line of road (and it is surprising how it could have been first traced out) is disheartening, as well as unsatisfactory; for imagining that considerable progress has been made, descent and rise alternately succeed ere the long wished-for summit be gained, which occupies at the least six hours to accomplish.

"The morning having proved fair, seemed, independently of the solemnity of the day (Sunday,) to fill our hearts with cheerfulness at the thoughts of making towards the scene from which we expected our curiosity to be so soon amply repaid for the distance we had come. The solemn silence that pervaded

the thicket in our approach to it threw a lambent gloom on the mind; the noise, however, of the waterfall, bursting suddenly on the ear, soon enlivened our anticipations; but here again a momentary disappointment supersedes these eager expectations, for, standing on the bed of the rocks, not thirty feet distant, the eye can discover nothing to awaken amazement: a few steps, however, nearer, the stranger is so overwhelmed with the immensity of the dread abyss, that he requires some seconds to collect himself before he gets sufficient courage to make the attempt to examine the awfully grand view that presents itself beneath him—he feels as if he were looking into the brink of eternity! nor is the situation in which he is compelled to be seated to enjoy the sight less strikingly perilous; he has also to lie down horizontally and look perpendicularly over a projecting rock at the very edge of the immense basin, into a descent that the eye can scarcely fathom from its profundity, and beholds a dreadful chasm hollowed out by the weight of the dashing torrents, which cause to ascend from the white spray that they form below, volumes of vapour which, rising into the atmosphere, mingle with the clouds above the highest mountains in the neighbourhood, and bouyant upwards borne, would rather seem to be the smoke of Ætna's fiery bowl, than the subtle extricated particles from the whirlpool of an equally dangerous element. The spectator sees the heavenly bow with all its prismatic colouring and splendour, reflected downwards through the salient aqueous globules athwart the surface of the unfathomed gulf, in the perfectness of the mundane semi-arch.

"I should imagine the circumference of the crater, which is shaped like a horse-shoe, to be about a quarter of a mile. In front of its open end, a descending forest majestically slopes down from the mountains, making the effect of the whole truly sublime; and some fields at the top, to the left, give a singular and pleasing combination to the aspect. Five separate bodies of water are hurled down this stupendous pool, the largest, at the N. E. angle, tumbles perpendicularly with its foaming current from the edge of the river, already described, clear to the bottom, in two distinct columns. At the next curve, and facing the position where we had a bird's-eye view of the whole, another large mass is seen to be propelled headlong; then

aslant the hollow channel it has formed, and gradually enlarging its surface in its descent, is buried in the boiling depth in union with the other. A more gentle rill, passing immediately over the second fall, makes a striking variety to the rush of its noisy neighbours. The fourth cascade is more distinctly observed, without the same exertion, in its southern direction, skirting the rocky steep of this enormous basin, and being expanded by the obstruction it meets from some projecting irregularities of stone. Hundreds of pigeons, about the size of butterflies, were sporting over the spray. We had to move round to a rising mound at the south-west corner, where the precipitated floods flow off, to be enabled to have a full view of the fifth fall, whose rolling foam, like soap-suds, edging from the summit to the termination of a solid mass of laterite, of several hundred feet in altitude, flashes through scattered fragments that lie rounded at its agitated base, and seek their repose in the general outlet. On the right rise the stupendous bulwarks of the western Ghauts, towering in the pride of their primeval magnificence. Several attempts were made to ascertain the depth of this wonderful reservoir: one by letting out strong twine, to which a weight was suspended, but this plan did not succeed after 300 or 400 feet; so another experiment was resorted to, and frequently repeated, of throwing down a coco-nut, and timing it as long as it continued visible, which always give the same result of eight seconds; and by my calculation, computing the centripetal force of the falling body to be at the rate of $15\frac{1}{12}$ Paris feet in a second of time, and increasing in proportion as the square of the distance, I make to be, from my product, $965\frac{1}{3}$, or about 1030 English feet, as far as I think it possible to ascertain it with any degree of accuracy.

"The falls of Niagara, of the Montmorency, the Missouri, and Tuccoa, are remarkable for the vast expanse of the falling sheets that are precipitated down them; but their height, in proportion, is very insignificant, with the exception of the first: neither do the celebrated falls of Gocauk, in Beejapoor, or that of Courtallum, in the district of Madura, exceed 200 feet in their descent; from which comparison it may be seen that those

of Gersuppah are not unworthy of being recorded among the 'wonders of the world.'"—*Asiatic Journal*, vol. xxviii.

2. *On the Climate of the Himmalaya.*

"I am only lately arrived from a trip through the old tract, viz. Kunáwar, which I had hoped would reward me with some consoling recompence for the sacrifice I made for its accomplishment; but I failed entirely in my object of establishing vaccination, owing to the folly and timidity of the Besáher Rajah. However, I have obtained some particulars in my journey, which, if not equivalent to the pecuniary losses I suffered, are at least interesting. The fossils and shells which occurred in my route are very strange objects. They are chiefly valuable from having myself seen them *in situ*. They comprise cockles, muscles, and pearl-fish, univalves, and long cylindrical productions, which are most singular objects. I found them lying upon the high land at 15,500 feet, in a bed of granite and pulverized slate; the adjacent rocks being at the same time of shell limestone. All the shells are turned into carbonate of lime, * and many are crystallized like marble. I came upon a village at a height of 14,700 feet;—are you not surprized that human beings could exist at such an elevation? It was yet the middle of October, and the thermometer on two mornings was 17°: what it is at *this* season of the year, I cannot guess; yet the sun's rays felt oppresive, and all the streams and lakes which were sheeted with ice during the night, were free and running by 2 o'clock. The finest crops of barley are reared here, and to irrigation and solar heat are the people indebted for a crop. The barometer gave for the highest field 14,900 feet of elevation; this verifies the observations, or rather inferences, on the limit of cultivation in the upper course of the Sutluj; and I think it quite possible, and even probable, that crops may vegetate at 16 and 17,000 feet. The *yaks* and shawl goats at this village seemed finer than at any other spot within my observation. In fact, both men and animals appear to live on and thrive luxuriantly, in spite of those speculations

* "All shells are composed of carbonate of lime principally. In the case of the porcellanous division, it is combined with a little, and in that of the mother-of-pearl shells, with about one-fourth of animal matter.—Ed."

which had calmly consigned those lofty regions, and those myriads of living beings to perpetual ice and oblivion.

"On the North Eastern frontier of Kunáwar, close to the stone bridge, I attained a height of more than 20,000 feet, without crossing snow, the barometer showing 14,320, thermometer 27° at 1 P. M*. Notwithstanding this elevation, I felt oppressed by the sun's rays, though the air in the shade was freezing. The view from this spot was grand and terrific beyond the power of language to describe. I had anticipated a peep into China itself, but I only beheld its lofty frontier all arid, and bare, and desolate. It was a line of naked peaks, scarce a stripe of snow appearing; yet every point had an angle of altitude of a few minutes, some half a degree, and at a very considerable distance; this argues at least 21,000 feet."—*Gleanings in Science*, No. 4.

3. *Account of an Ascent of Mont Elbroutz, the highest peak of the Caucasus, by a Russian party.*

This ascent was performed in July last, by General Emmanouel, Professor Kupffer of Casan, M. Zenz, for physical observations, M. Menetrier, for zoology, and M. Meyer of Dorpat, for botany. They were guarded by 600 infantry, 350 Cossacks, and two cannons, and their baggage was carried by six camels and several carriages. The central chain of the Caucasus is entirely formed of porphyry. The plateau upon which Mont Elbroutz stands is from 8 to 10,000 feet high, stretching out in the direction of east and west. This plateau is torn up in all directions by narrow and deep vallies, and crossed in its middle, from east to west, by a crest of rugged rocks of a picturesque character, and whose summits are covered with eternal snow. On this crest, and nearly in the middle of its length, there is a large and deep excavation, the middle of which is occupied by a cone which might be supposed to be entirely covered with snow, did we not see here and there the naked rocks appearing through it. This cone is Elbroutz, whose height exceeds, by 3 or 4000 feet, all the surrounding mountains.

The party passed the night at the foot of this cone in a

* The date is not mentioned. Using the mean result for October observed in Cal[illegible]s 20,419 feet, as the elevation.—Ed.

small hollow, sheltered by enormous blocks of black porphyry with white spots, in the middle of which was a small pool of snow water, but not a trace of verdure, and only a few lichens on the bare rocks.

Next morning, the 22d July, the party rose at 3 o'clock The thermometer was at 30° Fahr. and the sky clear. They got upon the snow, and experienced the difficulties and debilities which have been so often described in accounts of similar ascents. Towards its summit Elbroutz presents a series of naked rocks forming a species of stair, which greatly facilitates the ascent. MM. Kupffer, Menetrier, and Meyer, were so exhausted, that they resolved to rest for some hours, but during this delay the snow had grown so soft by the heat of the sun, that it became necessary to return, lest the bridge of snow which crossed the chasm should be melted. M. Zenz, who had gone on without stopping, reached the last platform of rocks, and was removed from the summit only by an interval of snow. The causes which rendered the return of the party necessary prevented them from advancing, and out of fifteen or twenty persons, Cossacks and Circassians, who attempted to reach the summit, only one succeeded, viz. a Circassian of the name of *Krillar*, who, inspired by the reward which General Emmanouel had offered, set off very early, and availed himself of the morning's frost.

The descent was extremely difficult from the cause already mentioned, and at seven o'clock in the evening they reached their camp on the banks of the Malka.

M. Zenz obtained the following results

	French feet.
Height of the mineral springs of Koustantirogorrk,	1300
——— of the limit of snow, - -	10,400
——— of the first station of rocks, -	13,600
——— of the station of M. Zenz, -	14,800
——— of the summit * above M. Zenz's station,	600
——— total height of Elbroutz, -	15,400

The temperature of the air at the limit of snow was 9° 6

* Taken with a micrometer.

Reaum. (about 54° Fahr.) At the station of M. Zenz it was 1° 5 Ream. ($35\frac{1}{2}$° Fahr.) while at the mineral springs it was 23° (81° Fahr.) at the time of the first observation, and 24° (86°) at the time of the second observation. The first of these observations gives 680 feet of difference of level for each octogesimal degree, and the second only 630 feet.

One of the most interesting results was a magnetic one. They found that the magnetic intensity decreased 0″,01 upon 24″ for every 1000 feet of elevation; a result which M. Kupffer considers as incompatible with the hypothesis of a magnetic nucleus which gives a much weaker decrease.—*Ann. de Chim.* Tom. xlii. p. 105.

ART. XV.—*Account of a series of Experiments on the construction of large Reflecting Telescopes.* By the Right Honourable LORD OXMANTOWN, M. P. Communicated by the Author.

HAVING, at different intervals during the last three years, tried a variety of experiments on the construction of specula for large reflecting telescopes, perhaps some of the results which I have arrived at may not be uninteresting to the scientific public.

In making these experiments, I have had two objects in view, *first*, to ascertain whether it was practicable to remove any of the defects known to exist in the large reflecting telescopes hitherto constructed; and, *secondly*, to simplify the process necessary for the manufacture of good reflecting telescopes of ordinary dimensions, so that the art might be no longer a mystery, known to but few individuals, and not to be acquired, but after many years of laborious apprenticeship.

A general statement of the results of my experiments will enable those who are at all conversant with the use of telescopes to decide how far I may have succeeded in effecting anything useful.

I propose to avoid as much as possible entering into detail. Within the limits necessarily prescribed for a single article in a periodical work, it would be impossible to do so with any ad-

vantage. In subsequent numbers of this *Journal*, I shall have an opportunity of giving a particular account of the different processes and manipulations which I have employed, so that any person of ordinary mechanical skill who may think it worth while to erect the necessary machinery, will be enabled to obtain with certainty the same results.

As a general inference from all the facts which have come within my observation, I can have no hesitation in stating, that the reflecting telescope is still susceptible of very great improvement,—that it has by no means reached the utmost limits of perfection. If we except the defects arising from spherical aberration and the inflection of light, which I think are not irremediable, and are, in my opinion, much overrated in practice, the remaining defects are entirely of a practical nature, and to be overcome by practical means, by numerous and accurate experiments, such as a patient consideration of the difficulties to be surmounted must necessarily suggest.

In order to render the following account intelligible, I will endeavour to put the reader in possession of the difficulties he would have to encounter were he to proceed to construct a large telescope in the common way, and the defects he would probably find in the instrument when finished. He would of course first proceed to cast the metal. As earthen-vessels would not be sufficiently capacious, he would employ either iron ones or a reverberating furnace. If he tried iron vessels, before a large quantity of speculum metal, for instance three or four hundred weight, was raised to a proper heat for casting, he would find that the metal had imbibed some of the iron, andwas injured; or perhaps, if he was less fortunate, and the fire had been a little mismanaged, that the speculum metal had promoted the fusion of the iron, and so passed out through the crucible. The reverberatory furnace would then be resorted to. Much difficulty would occur in combating the continual change of the quality of the metal from the exposure of so large a surface to the action of the flame. However, the metal once cast, the next process would be to anneal it. He would then find that the speculum would fly to pieces before it was cool, unless the alloy made use of was less bright, less white, and in every respect inferior to the best speculum metal. The next process is to grind the speculum,

which, though laborious, does not require much exactness, and lastly, to polish it, which every one knows is attended with very great difficulty. Making a probable estimate of the success likely to be obtained, after a great number of abortive attempts, a metal would be completed, having a tinge of yellow deeper in proportion to its size, with perhaps a defective polish, and certainly a figure by no means perfect; such a metal would not bear any considerable power with tolerable distinctness. What I have just stated is the result of experience. That I have not overrated the difficulties and defects, will appear evident to any one who is conversant with the late Sir W. Herschel's writings. Since Sir W. Herschel's time, no improvement that I am aware of has been made in any part of the process of making the specula of telescopes; none of the difficulties which he stated as existing have since been surmounted; and none of the defects which his skill had not removed, have since yielded to the dexterity and perseverance of others.

From the accounts which we have of Sir W. Herschel's labours, it appears, that, in proportion as he increased the size of his specula, he was obliged to debase the quality of the metal made use of. Dr Pearson, in his *Practical Astronomy*, states, that the proportion of tin to copper used for the metal of the twenty foot telescope was 7.75 to 20,—an alloy certainly extremely low. He also states that the metal of the forty foot telescope was still lower, and was composed of blocks of an alloy purchased at a warehouse in London. The weight of the large metal for the forty foot telescope was 1050 pounds, the diameter four feet eight inches, the thickness at the edge two inches, and in the middle one inch and a quarter. It is difficult to conceive how a metal of such weight, so great a diameter, and so little thickness, could retain even a tolerable figure in the different positions of the telescope.

It is also well known, that Sir William Herschel, at the commencement of his career, polished 400 specula of different dimensions; content if he could procure one tolerably good one out of a great number. Such were the difficulties that he had to encounter; and I am not aware that anything has been published since that time, tending materially to diminish

the labours of the experimentalist, or of the practical optician. Sir William Herschel also found that he was unable to polish large specula so as to give them as accurate a figure as small ones. His twenty foot telescope, which I believe has been admitted to be the best reflecting telescope ever constructed, was seldom used with a power above 200; and I believe the same observation will apply with equal correctness to the forty foot telescope.

The defects, therefore, common to all very large specula hitherto constructed may be thus stated: a defective metallic composition ill suited either to receive or retain a polish, or to show objects of their natural colour and brilliancy; a want of sufficient stiffness in proportion to their weight to enable them to retain their figure with that great degree of exactness necessary; and *thirdly*, a want of as perfect a polish and figure as has been given to small specula.

My first experiments were undertaken with the view of obviating the two first defects. Having had some experience in the process of painting on glass, in which the glass is made red hot, and subsequently annealed, it occurred to me that the precautions employed in that process might be transferred with advantage to the construction of specula, and that it might thus be practicable to prevent large specula, cast of the highest metal, from cracking before they were finished. It also occurred to me that large specula might possess sufficient stiffness without any additional weight, were they cast thin, but with a deep rim round them connected by ribs of equal depth. A speculum, fifteen inches diameter, was accordingly cast with a rim round the edge two and a half inches deep, and half an inch thick, and with two ribs of the same depth and thickness as the rim, intersecting each other at the centre of the back of the speculum. The composition employed was the best speculum metal. As soon as the metal had become solid, while still red hot, the sand was entirely removed from the four cavities at the back between the ribs and the rim, and the metal, still red hot, was placed in a red hot iron vessel upon a bed of wood ashes, and the cover of the vessel, also red hot, was then put on, the whole was immediately placed in a red hot oven and shut up there. In about forty-eight hours the metal was perfectly cool. It was

then examined, and was found to be broken in several places. A second metal was then cast precisely similar to the former one and similarly treated, but the composition was a little lowered. It also cracked, but not so much. A third was cast, the composition being a little lower than that of the second; it also met with a similar fate. A fourth of a still lower composition was defective in casting, but did not crack; the fifth turned out well. The fourth and fifth were of the same composition. The metal has a slight tinge of yellow clearly perceptible when compared with metal of the best composition. It does not take so high a polish, and is more subject to tarnish. The metal, however, was much higher than that of Sir William Herschel's twenty-foot telescope.

Upon the whole, the result of the above-mentioned experiments was by no means satisfactory. I found that I could not cast a speculum of the moderate dimensions of fifteen inches, without reducing the composition considerably below the highest standard. It was also quite evident that the composition should be still lower for a metal three feet diameter; such a metal might indeed have been made of one-third the weight which would otherwise have been necessary, by casting it like the fifteen inch metal with a rim and ribs at the back; but still the defect in the quality of the metal would have remained, which appeared to me to be a decisive objection to the construction of such an instrument.

After several fruitless attempts to combat this difficulty, experiments were tried to ascertain whether it would be practicable to cast specula in different pieces, and to unite them together by tinning the surfaces. This was found to be practicable, but it was abandoned for the following plan, which I think was perfectly successful.

An alloy of zinc and copper can be formed, which will expand and contract with changes of temperature more or less than speculum metal, according to the proportion of the ingredients. Experiments were made, and it was found that copper $2 + \frac{5}{4}$, and zinc 1, would give an alloy possessing the required property of giving expansions and contractions with a change of temperature, not sensibly different from speculum metal. This alloy is malleable, ductile, and easily worked.

With this alloy a speculum was cast fifteen inches diameter, with a rim and ribs similar to the one before described, but in every respect thinner,—not half its weight. It was turned smooth and flat at one side and tinned. Six pieces of the highest speculum metal were then prepared one quarter of an inch thick, and fitted so as to make, when put together, a complete circular disc fifteen inches diameter; these were then arranged on the flat tinned surface of the brass speculum; the temperature was then very gradually and equally raised till the tin was in fusion, and till every part of the under sides and edges of the speculum metal was perfectly tinned. A slight pressure was then uniformly applied, and the temperature gradually reduced till the tin became solid. We then had a speculum composed of zinc and copper plated with speculum metal one quarter of an inch thick, adhering to it as firmly in every part as if it had been one piece of metal. This metal was ground and polished by the machine described in a former number of this *Journal*. It has a focal length of twelve feet, and as there is a set off of about a quarter of an inch at the edge, it has fourteen inches and a half clear aperture. It far surpasses the other metal in the brilliancy and whiteness of the image, as was of course to be expected. In other respects it is the same, as they both bear distinctly a power of 600 at a printed paper, or at the cut stone pinnacles of a church distant about 300 yards. There can be no mistake as to the powers, as I make use of single lenses. Only one favourable night has occurred since the stand and its appendages have been brought to such a state as to render the instrument tolerably manageable. The new moon was on that occasion examined with powers from 80 to 600, and very perfectly defined. The pole star, ε Bootis and some other stars not requiring high powers were well shown. From the defective state of the machinery for giving motion to the telescope high powers were not employed, and farther trials were deferred till another opportunity. The stand is precisely similar to Mr Ramage's, but the pulleys and some other appendages are not complete. From a comparison of the instrument in the day time with others which perform extremely well, I entertain very sanguine expectations of its powers upon the dif-

ficult double stars. A six inch metal was constructed about a year ago upon the same principle, which performed well; and, upon the whole, I have not been able to discover that these plated specula are subject to any defects to which those upon the common construction are not equally liable.

It is evident that such specula can be constructed of the finest metal and of any size which may be desired, and that with the greatest facility. A metal upon this plan two feet diameter was commenced a few days ago, and is in so forward a state that it will probably be completed in three weeks. A second speculum of the same dimensions could be completed in a shorter time, as no fresh tools would be necessary.

This metal is for a tube twenty-six feet long and three feet diameter. The tube is finished and the stand is nearly so. I propose to make another metal for it at a future time of the full aperture; but whether single, or upon the plan described in Number 17 of this *Journal*, I have not yet determined. Further experiments are to be tried with the six inch metal, the subject of the article before quoted. A few months after that article was sent to the press, an eighteen inch metal of twelve feet focus upon the same plan was commenced; the different parts were cast. In the meantime some further experiments were tried with the six inch metal; the power of adjustment afforded much facility for comparing the spherical aberration with the defects proceeding from other causes. By retaining but a section of the aperture the spherical aberration was preserved, while the defects arising from inaccuracy of surface were reduced with the diminished aperture. The distinctness of the images increased as the surface lessened, and the image resulting from the union of the two images was as distinct as each had been when separately examined. Upon the whole, it appeared evident, that, although the speculum was improved by the adjustment for spherical aberration, still defects continued, arising from the imperfections of its surface, much greater than the spherical aberration. The speculum was repolished by hand with the utmost care more than fifteen times, but without any considerable improvement. It was compared when taken from the polisher with a common speculum of the same dimensions, and they were found to be both alike.

The compound one when adjusted was somewhat superior. The polish of both was very good, but the surface of course was not so. The solid speculum was about as good as the average of similar metals which I have seen. When these metals have been ground and polished by machinery, further trials shall be made with them.

After the experiments which I have just described, I determined to defer for the present expending any further labour upon the eighteen inch compound speculum, and resolved to endeavour previously to discover some certain method of giving specula a more accurate surface. I was confirmed in that determination from an apprehension that the castings were not as perfect as they should have been. All my workmen were trained in my own laboratory without the assistance of any professional person, and none of them had previously seen any process in the mechanic arts; and I was not myself then acquainted with the precautions necessary to insure the production of an alloy of zinc and copper in the due proportions. There was, therefore, a great probability that the castings were defective.

The polishing apparatus described in No. xviii. of this *Journal* was completed about that time. It has since undergone some alterations. The different motions are now obtained by cog wheels and leather bands. Several other minor alterations have also been made, both in the apparatus and in the manner of conducting the whole process, which have produced the most material improvement. The results obtained by machinery are very nearly uniform. Where a uniform combination of motions produces a defect, that defect will uniformly recur, and may, therefore, with great facility, be traced to its course and corrected. Such has repeatedly been the case. The same specula have been repolished a great number of times, and the performance of the machine has improved faster than I could have anticipated.

The practical optician will rarely give you the slightest intimation of the process of working specula which he finds the most successful, nor is it perhaps to be expected. It is therefore impossible to describe with certainty his mode of proceeding; but I believe the practice is to work the speculum till it

becomes warm, and the polisher is almost dry; and I rather think that practical opticians suppose it is impossible to communicate a fine polish without this mode of proceeding. From the experiments which I have tried, I have little doubt but that the figure of the speculum is injured by working it upon a polisher nearly dry, and that the injury is in some degree proportional to the time it is so worked:—at any rate large metals must be finished upon a moist polisher. Until very lately I had not found out a method of communicating a very fine polish to a cold metal worked upon a moist polisher.

As fine a polish as can be desired can now be given to a metal of any temperature which we may fix upon above the freezing point. Both theory and practice lead to the same conclusion, that it is desirable to polish a speculum at a temperature as nearly as possible the same as that at which it is to be afterwards used, particularly if the speculum is of large dimensions.

In the preceding account, I have endeavoured to give a general outline of the different objects which I have attempted to effect, and I have, as far as was in my power, conveyed an accurate idea of the degree in which I conceive I have been successful. Further experiments shall be tried, and the specula already completed shall be subjected to the severest tests. Should I then feel satisfied that specula obtained by these processes are as perfect as I have ventured to anticipate, I shall then have the pleasure of placing some of them in the hands of the able and persevering observers of the present day, where they will be fairly tried, and, if they have merit, will certainly not remain idle.

The examination of the heavens commenced by the late Sir William Herschel, and, prosecuted by him with such success, still continues. New facts are recorded; and there can be little doubt but that discoveries will multiply in proportion as the telescope may be improved.

It is perhaps not too much to expect, that the time is not far distant when data will be collected sufficient to afford us some insight into the construction of the material universe.

ART. XVI.—*Notice of some of the Birds of Madeira.* By C. HEINEKEN, M. D. Communicated by the Author. (See last Number, p. 229.)

CATHARTES Percnopterus, (Tem.) The only individual of this genus ever known to have visited this island was shot while flying slowly over the skirts of the city on the 3d of November 1827, and is now in my possession. It answers in colour to the intermediate stage between the first year and adult plumage of Cuvier and Temminck. It was in good condition; and the stomach full of putrid flesh and maggots. For about a fortnight before its arrival the wind had been blowing so strong as to drive the gulls close in shore; and it either came to us from the coast of Africa, or more probably from Teneriffe, if, as I have been informed, it breeds and is stationary there.

We have three stationary birds of prey, viz. *Falco buteo*, (Manta,) *F. tinnunculus*, (Francelho,) and *F. nisus*, (Furo bardo). Bowdich mentions the *F. Æsalon*; but, as I have never either seen or heard of it, and as he omits the *F. tinnunculus*, which is so common that three or four at a time may constantly be seen over the skirts of the town, it is probably a slip of the pen, and the kestrel, not the merlin, intended by him. He also calls our manta "a new species of eagle, &c;" but I suspect that his observations of the bird were very superficial, and confined probably to a single and young individual, for I have had at different times at least eight specimens (two of which were living) of both sexes and various ages,—have shown it to two or three sportsmen and a couple of good practical ornithologists, and compared it with the descriptions of at least half a dozen authors, and still I cannot (and I fain would) exalt it above the "*common buzzard.*" It, however, seems doomed to misrepresentation. In an amusing little work (*Rambles in Madeira*) it is called "a vulture." Now this for a desultory "rambler" too imaginative to condescend to genera, species, and such like trifles, is not too much amiss, but surely his "*scientific*

friend B," (as he calls him,) might have given his elbow a friendly jog upon the occasion.*

Oriolus galbula. Several orioles were shot here in May 1828, after several days of sirocco (S. E.) wind, which blows directly from the coast of Africa. Some stragglers were met with a month or two later, but none since. I did not see one young.

Sturnus vulgaris. Two were seen and one killed on the beach at Santa Cruz, about three leagues to the east of Funchal, during the summer 1829. I had heard of, but not seen, the bird here before, and it is only an accidental visitor. At the Canaries and Azores, it is, I am told, common.

* "Men of *all sorts* seem to take pride to *gird at us!*" The length of our island was only determined the other day; the breadth is still *sub judice*; and whether we are Europeans or Africans, a matter in dispute. The pathetic tale of the first discovery of the place is like Adah, "fair" as fancy, "could make its offspring."—"Still it is delusion," I fear, and Machim and his Anna as much the "sweet creation of some heart," as Numa and his Nymph. The poetical Bowles sets our woods "trembling to a kiss." The matter of fact Cordeyro set them "on fire for seven years!" Israeli, in "*The Curiosities of Literature*," says "a modern traveller (he should have recorded the name) assures us that he has *repeatedly* observed in the island of *Madeira* that the *lizards* are attracted by the notes of *music*, and that *he has assembled* a number of them by the powers of his instrument!" Gourlay made them into *raw* sandwiches (the cannibal) for breakfast, and thus *cured* an *incurable* disorder. The same worthy makes Pico ruivo 8000 feet in height,—a *trifling* addition to its real elevation of some 2000 feet or thereabouts; and the flippant writer of "*Six Months in the West Indies*," amongst other unheard of wonders, makes a well known ravine in the centre of the island (the Canal, and from which one of our largest mountain torrents rushes impetuously into the sea) about 500 *feet below the level of the ocean*, by an *insignificant* error of only 2000 feet of depth! Even Spix and Martius could not resist the endemic which seems to invade our shores, for in one short day they detected half our population in Funchal to consist of Negroes, although there are not a hundred distributed over the whole island. Bowdich I add to the list, much more in sorrow than in anger. His means were not commensurate with his ends; and, had time and opportunity been afforded him, he would, I have no doubt, have seen and corrected many of the errors into which haste, inauspicious circumstances, and the *res angustæ domi*, betrayed him; and the best compliment I can pay to his memory is, to point out whatever may appear to be erroneous, under the conviction, that doing so would have been congenial to his wishes if living.

Turdus iliacus. The only specimen I have met with of this bird was in January 1829, during weather unusually severe for this climate, and after a continuance of north west winds.

Turdus merula. Common and abundant. Bowdich says something about its differing from the European species, by having "the beak dark brown, and merely edged with yellow;" but he surely must have been deceived by a hen or young cock, for it is called by the Portuguese, par excellence, "o merlo com beco amarello," (with the yellow beak).

Sylvia rubecula. Common, and the robin of England in every respect.

Anthus pratensis, (Tem.) The "meadow titling" of Fleming, and "pipit lark" of Bewick, but *not* the *titlark* of Pennant, although Fleming gives the latter as synonymous with his meadow titling.

* *Alauda arvensis*, (Tem.) Is seen only from autumn to spring, and neither sings nor soars. Answers to the essential character of the *A. arvensis* of authors, but has not the habit of that bird. Will be described at some future time.

* *Cuculus Pisanus?* (Turt. ?) Brown-black; crested; throat tawny; neck and breast white; wing-covers tipped with a white spot; primaries and secondaries edged only at their tips with same; tail (of ten feathers) nine and a-half inches long; two lateral feathers one-third shorter than rest, and obliquely white the lower third of their length; middle all black; rest tipped with white; iris chestnut; bill black; legs brown-black; length sixteen, breadth twenty-three inches. Shot on 25th February 1828, at Praya Bay, about a league west of Funchal, during a prevalence of north winds. Another was in company, but escaped. On the 15th August 1829, a second specimen, differing only in having rufous remiges, was killed at the Prazeres, about ten leagues further westward on the same line of coast. The sex was not in either case ascertained.

Musophaga Africana, (Tem.) This bird was shot in December 1828, in a garden in the city, and had more the appearance of one which had escaped from confinement (although that could not be ascertained) than crossed the seas.

Upupa epops, (Tem.) Not unfrequently met with, but never

known to breed here. Bowdich speaks of the *U. capensis*, but does not mention the *epops*. The former I have not met with.

Merops apiaster. Of this, one example, but no particulars.

Hirundo rustica. An occasional (some say periodical) visitor. Certainly never know to build here.

Perdrix rubra. Stationary, and our only partridge.

Columba Turtur. Accidental. Not known to build here.

C. livia—C. œnas? Stationary. Also *C. palumbus* in small numbers.

Œdicnemus crepitans, (Tem.) The only individual remembered here was killed 4th November 1827, near the Praya formosa. The wind had been northerly for some time.

Ciconia nigra. This bird was killed on the 9th of the same month at Santa Cruz. Seen occasionally before.

Ardea cinerea. No note of this bird. Not unfrequently met with, but never breeds here or remains (*escapes?*) long.

Ardea minuta. Occasionally driven on the island.

Numenius phœopus—Strepsilas collaris, (Tem.)—*Tringa variabilis*, (Tem.)—*T. cinerea?* Frequent visitors, and in moderate numbers, but not known to build.

Scolopax major. A winter visitor, but doubtful if periodical or occasional; probably the former.

Gallinula chloropus. One example here, and another at Porto Santo.

Gallinula crex, (Tem.) Do.—Killed, August 1829, near Funchal.

Fulica atra. Occasionally. The one which I have was taken in a poultry yard in the city. This, from its appearance, is, I have no doubt, the bird which the natives call "Freira" (*Nun*,) although (good Catholics as they are!) their agreement is by no means *conventual* on the subject.

Larus argentatus, (Tem.) Our only stationary gull.

Larus tridactylus, During the winter of 1828–9, which was unusually severe for this climate, many were seen in the bay and caught with hooks, knocked down with stones, &c. Towards the east point of the island I am told that a few are often met with.

Sterna nigra. One example this autumn—*S. Hirundo* common, and I believe stationary.

Procellaria Anglorum. A specimen was procured and stuffed during the summer of 1828, but as I was from home I know no particulars about it. At the same time with the kittiwakes a young

Sula alba was caught at sea with a hook. Lisbon has, I believe, been considered hitherto its southern limit.

Procellaria puffinus, (Tem.) Arrives here in spring; breeds, and quits in autumn.

Procellaria pelagica. One example during present summer. Full one inch longer and nearly four more in breadth than commonly stated. I have not, as far as I remember, mentioned here any of those birds already noticed either in this or the *Zoological Journal,* or such generally known and universally distributed ones, as the common owl, wrens, wagtails, chaffinch, goldfinch, linnet, &c., wishing to confine myself to those either peculiar to us, or not known to belong to the island, or differing in their economy and habits from their congeners elsewhere. The majority are only occasional and accidental visitors, and nine in ten perhaps are driven over from the coast of Africa. Of those in this paper marked *, as well as of all described either in this *Journal* or the *Zoological,* as *probably* new, specimens have been sent to the Zoological Society. We have at least three species of the bat, † viz. *Vespertilio mystacinus,* (Leisl.) *Plecotus communis,* (Geoff.,) and *Dinops Cestonii,* (Savi.) The latter is, I have little doubt, the *Dinops* of Savi, although I am doubtful about the species, and am unwilling to describe it from only one specimen. I find that Temminck considers that genus synonymous with the *Dysopes,* Illig. and *Molossus* and *Nyctinomus,* Geoff., and I am the more convinced of its generic identity from the difficulty I found in determining to which of the four it best answered. Bowdich says "*The* bat (which?) is more than specifically distinct, &c."—"has clusters of *orange warts* on

† The *Vespertilio murinus* I have never met with, and, from the great number of genera and species, and the confusion still existing regarding them, I give the specific names of those which I have seen rather doubtingly; especially as I have had only single specimens.

the ears, &c." and makes it a new subgenus. I have now a specimen of the *V. mystacinus* in spirits, with a *cluster of orange Caris vespertilionis*, Latr. on each ear; but I do not mean to assert, although I shrewdly suspect, that we only give different names to the same thing. Still less would it become me to determine whose nomenclature is the better one, should it be the case. C. HEINEKEN, M. D.

FUNCHAL, *Madeira, 20th October* 1829.

P. S.—Since the above was written, another young *Sula alba* (but, like the former one, with the bill and claw *not serrated*) and a young *Anas Crecca* have been taken. Several of the latter I saw coming from the N. westward a few days back. I had heard of it as an occasional visitor before. The wind has since, and for a long time previously, been N. easterly.

ART. XVII.—*An experimental examination of the electric and chemical theories of galvanism.* * By WILLIAM RITCHIE, A. M. F. R. S., Rector of the Royal Academy at Tain.

1. THE continental philosophers still continue to adopt the electric theory of galvanism proposed by Volta, whilst those in Britain as uniformly follow some modification of the chemical theory proposed by Dr Wollaston. From this diversity of opinion we may safely conclude, that the experimental proofs for the truth of either theory are not sufficiently powerful, to command the assent of all capable of appreciating the weight of such evidence. I have therefore ventured to lay before the Society the following experiments and observations; as they appear to me to establish the truth of some modification of the chemical theory, and to demonstrate the fallacy of the principles on which the electric theory rests.

2. The fundamental principle assumed by Volta, and supported by his followers, is, that if dissimilar metals be brought into contact they are instantly thrown into opposite electric

* *Phil. Trans.* part ii. 1829.

states. This he conceives to be a new law of nature, and claims to himself the honour of the discovery. He conceives that its truth is proved by the following experiment:—

Let a plate of zinc be soldered to a plate of copper at two edges. Hold the plate of zinc in the hand, and touch the under plate of a delicate electric condenser (le condensateur à lames d'or) with the copper plate, whilst a moistened finger is applied to the upper plate of the instrument. Remove the compound plate and the moistened finger, and then lift the upper plate of the instrument by its insulating handle, and the slips of gold leaf will be found to diverge. Taking for granted the truth of the experiment, the conclusion which Volta deduced from it by no means follows as a legitimate inference. Dr Wollaston has shown that a galvanic effect is produced by dissimilar metals with the moist air of the atmosphere acting as a chemical agent and an imperfect conductor. The same fact is proved by the electric column of De Luc. The plate of zinc becomes partially oxidized by the oxygen of the atmosphere, electricity is generated or set at liberty, and the film of moist air in contact with the two metals, acts as the fluid conductor in an ordinary voltaic arrangement. If the compound plate be coated with electric cement to exclude the chemical action of the air on the zinc, I will venture to predict that no decided electric effect will take place. Until the supporters of the electric theory show by direct experiment that an electric effect does take place with this modification of the apparatus, we must view the whole of their reasoning as founded on a gratuitous supposition. Having thus shown that Volta and his followers have overlooked what appears to me to be the very cause of the disturbance of electric equilibrium in the two metals, I shall now demonstrate that the other principle on which the theory is built is equally unfounded. This will appear obvious from the two following experiments:—

Exp. I.—Having poured into a watch glass a quantity of diluted sulphuric acid, I placed on the surface of the fluid a piece of gold leaf, which was connected with one of the cups of a delicate galvanometer. I then placed a disc of platina foil in the fluid below the gold leaf, and connected it with the other cup of the instrument; scarcely any electro-magnetic ef-

fect was produced. Having removed the acid, I substituted water containing condensed chlorine: a very decided electro-magnetic effect was produced. A similar effect was produced by using nitro-muriatic acid, or aqua regia as it was formerly called, instead of the chlorine. The needle of the galvanometer in both cases turned round in the same direction as it does when zinc was substituted for the gold leaf and copper for the platina. Having tried, by the common method, the conducting powers of the diluted sulphuric acid and the water containing chlorine, I found that the diluted acid was the most powerful conductor. When the preceding experiment was repeated with discs of zinc and copper instead of discs of gold and platina, I found that the most powerful effect was produced when the diluted sulphuric acid was used. This experiment clearly proves that the interposed fluid does not act merely as a conductor to the electricity excited by the imaginary electro-motive force, since in the first case the electricity generated is greatest when the conducting power of the fluid is least.

Exp. II.—Having made a small rectangular box divided into two equal compartments by a diaphragm of bladder, I introduced into one of them a disc of hard copper, and into the other an equal disc of soft copper. These discs being connected with the cups of the galvanometer, and the chambers filled with water, a considerable galvanic effect was produced, and the needle turned round as it does when the place of the hard copper was supplied with a disc of zinc. I then poured a little nitrous acid into the chamber containing the hard copper, and observed that the effect was diminished. By adding a little more acid the needle turned round several degrees in the opposite direction. This experiment completely overthrows the assumed principle that the galvanic effect increases with the conducting power of the fluid interposed between the metallic plates, since by increasing the conducting power of the fluid the effect was diminished, and by a proper increase was completely destroyed. It is a curious fact, that if nitric, sulphuric, or muriatic acid be used instead of the nitrous, the results will be quite the reverse.

Having thus, I trust, satisfactorily shown that the electric

theory is founded on false principles, I shall now very shortly examine the truth of the most generally received chemical theory of galvanism.

3. Dr Wollaston assumes that positive electricity is set at liberty by the combination of oxygen with one of the metals. This principle is frequently true, but in many cases it is totally false. This will be rendered obvious by the following experiments :—

Exp. III.—Immerse two equal discs of zinc, connected by wires with the galvanometer, into the chambers of the rectangular box formerly used, and fill both compartments with water; no action will of course take place. Pour a little sulphuric, nitric, or muriatic acids into one of the chambers, a considerable galvanic effect will be produced, and the needle will turn in the same direction as it does when copper is substituted for the plate of zinc immersed in the chamber containing the water alone. This agrees with the chemical theory. Again, instead of the above acids use nitrous acid, and the needle will turn round in the opposite direction. The same thing holds when discs of copper or iron are employed. This is completely at variance with the chemical theory, since that plate is negative, or corresponds with copper in the standard battery, on which the greatest chemical action of the fluid takes place. The following experiment is also hostile to the generally received theory.

Exp. IV.—Having taken two pieces of block tin, I cut the surface of one of them into ridges by means of a three-cornered file, so that the surface was doubled. With these two pieces I formed a binary combination, and immersed them in diluted nitro-muriatic acid; a very considerable electro-magnetic effect was produced, and the needle turned round in the same direction as it does when a plate of zinc is substituted for the plane disc in the standard battery. It is obvious that there must be a greater chemical action between the acid and the furrowed plate than the other, and yet the furrowed plate corresponds with copper in the standard battery, on which the least chemical action takes place. The results obtained in the following experiment were also unexpected :—

Exp. V.—Take equal pieces of soft zinc, copper, iron, or

brass, beat one of each pair on a smooth anvil till they are as hard as possible. Form a binary combination with pairs of the same metal, and use diluted sulphuric acid, and it will be found by the galvanometer that the hard metal in each case corresponds with zinc in the standard battery. If two pieces of steel be employed, one of them soft, and the other tempered, a galvanic effect will be produced, but of a contrary character. The soft steel will correspond with zinc, and the hard with copper, in the battery of comparison. The result of the following experiment seems also at variance with previous notions on the subject:—

Exp. VI.—Having procured two small iron bars, with the ends made bright with a file, and copper wires connected with the other ends, I heated the end of one of them, connected the wires with the galvanometer, and then immersed the hot and cold ends in water; a considerable action took place, and the cold iron was found to correspond with zinc in the standard battery. Since oxygen combines more rapidly with hot than with cold iron, positive electricity ought, according to the received opinions, to have appeared at the hot iron, whereas the contrary was actually the case. The following experiment is not only at variance with the theory of Dr Wollaston, but seems also hostile to some of the generally received notions of chemists.

Exp. VII.—Let a cylinder of copper, about an inch in diameter, and two inches long, have a small copper tube soldered in one end, whilst the other end is left open. Let a small cylinder of zinc having a copper wire soldered to the lower end, be placed within the copper cylinder. The wire, being covered with a thread and passed through the tube, is firmly cemented with electric cement, metallic contact being carefully avoided. Another end having a strong brass tube with an internal screw is now soldered in the top of the copper cylinder. The interior surface of the cylinder of zinc is covered with electric cement to prevent the acid acting on it. The whole is now nearly filled with water, and a little sulphuric acid is introduced into the zinc cylinder by means of a very slender glass funnel. The whole is now completely filled with w[illegible]d a solid screw dipped in electric cement, and screwed [illegible]f the brass tube, whilst it is heated,

renders the whole completely air-tight. The acid is now to be mixed with the water by frequently inverting and shaking the cylinder. If the copper and zinc cylinders be connected with the galvanometer, the battery will continue to act for a day or two with the same energy as if the whole had been left exposed to the air. As there is no room for the disengagement of hydrogen, the oxygen of the water cannot combine with the zinc to convert it into an oxide; nevertheless chemical action goes on, and the zinc is dissolved in the acid. From this experiment it is obvious that the oxidation of the zinc and the combination of nascent hydrogen with the electric fluid, as Dr Bostock supposes, has nothing to do with the production or transfer of the electricity which appears at the surface of the zinc. The metal is still, however, dissolved or reduced from a solid to a fluid state; and as its capacity for caloric has undergone a change, may not its capacity for the electric fluid have also undergone a certain change? Hence it is possible that the true theory of galvanism may be more intimately connected with that of latent heat than has yet been supposed. Since the zinc is dissolved without the assistance of oxygen from the water, it appears that the atoms of the acid have combined with the pure brilliant atoms of the metal, without the necessity of the metal being first converted to an oxide.

From the short view that I have taken of this interesting subject, it appears that the electric theory is quite unfounded, and that the chemical theory will require some modification to embrace the facts contained in the last experiments. This I shall not, however, attempt at present; as my object in this paper is rather to demolish old fabrics and collect new materials, from which a more substantial edifice may be raised.

ART. XVIII.—*On the Magnesite discovered in Anglesey.* By WILLIAM HENRY, M. D. F. R. S., &c. Contained in a Letter to Dr HIBBERT, dated 5th Dec.

WHEN I showed you, a few weeks ago, a specimen of magnesite which I had found in the autumn of 1828, in Anglesey,

you thought that this new locality deserved to be the subject of a notice in one of the scientific journals; and I send, therefore, the following short account of it for insertion in that with which you are associated:—

At a short distance from the Parys mountain (I believe S. W. and within a mile of it) there is a low hill composed of green serpentine, which is probably similar in its character to other hills of about the same elevation, which are seen to rise at no great distance. The serpentine is traversed by narrow veins filled with a mineral, which, on first view, struck me as resembling the hydrate of magnesia discovered by yourself in Shetland. It is of a greenish white colour; a foliated structure; translucent at the edges; rather soapy to the touch; and soft enough to yield, not easily however, to the nail. Its specific gravity (twice taken) is 2.820. On chemical examination it was found to differ essentially from the Shetland hydrate, which, according to Dr Fyfe's analysis, is the proto-hydrate of magnesia. The Anglesey mineral dissolves very slowly in pretty strong muriatic acid, with an escape of carbonic acid gas, the volume of which, from 100 grains, may be reckoned to be equivalent to about 19 grains. The solution, however, is not complete, even when assisted by heat; from 54 to 60 parts remaining undissolved, and when a small fragment has been used, it preserves its general form. The dissolved part consisted almost entirely of carbonate of magnesia and carbonate of lime, in the proportion of about 28 of the former to 12 of the latter. Both these carbonates must, in the mineral, be anhydrous; for no difference, that can be counted upon, is found between the loss sustained by a white heat, and that effected by solution in acids.

The insoluble portion I have not had time to analyze; but it appears to me very much to resemble common talc. This may have contained cavities, which may have been afterwards filled by an infiltration of magnesite. I throw this out, however, as a mere conjecture.

It is probable, that, if the rock were opened out by blasting, much finer specimens might be obtained than any I possess, which are small and somewhat weathered. It is not unlikely, also, that the chrome-oxide of iron would be found on the same spot.

Art. XIX.—HISTORY OF MECHANICAL INVENTIONS AND OF PROCESSES AND MATERIALS USED IN THE FINE AND USEFUL ARTS.

On the Application of Steam to the purposes of destroying all Kinds of Vermin on Board Ships.

The destructive ravages of white ants, when once they find their way on board the vessels in India, have long been the bane of that description of property, aggravated too by the secrecy with which their operations are frequently carried on, and by the absence of all means of prevention. Property of acknowledged value, to the extent at times of above a lac of rupees, has become, on the presence of this destructive animal being discovered, almost valueless; since hitherto, when once known to have infested a vessel, no instance, we believe, has occurred of their ever having been wholly extirpated; thus not only attaching a suspicious character to the vessel, but occasioning continued, and sometimes very heavy and expensive repairs. Indeed it is scarcely possible even to trace the extent of the evil with any degree of certainty. A ship may undergo a very heavy repair of damages occasioned by the ants, and every possible means may be adopted with a view to ascertain the existence of further damage, without success; yet a very few weeks may show another part of the vessel to be infested to a great extent, rendering necessary a yet further repair.

It may reasonably be supposed, that such destruction of property would not be permitted to continue, without some attempts at a remedy; of these, the most effectual have hitherto been the application of extreme cold, or sinking.

The former of course could only be carried into execution by sending the vessel infested to a cold climate, there to be laid up for a winter. Independent of the loss occasioned by the non-employment of the vessel, the remedy has never been, we believe, complete. A stop has been put to their ravages for a time, but a return to a warm country has shown that the animals have not been effectually destroyed; either they have merely been reduced to a state of torpidity, or if the living animal has been destroyed, the eggs have not been deprived

of their power of production. The same remark may be made in regard to sinking, independent of which, the expence and difficulty attending the operation render it little better than submitting to the evil itself.

That so obvious a remedy as that of filling a ship with steam, should, in these times, when its employment may be said to be almost universal, have been so long unthought of, is not a little remarkable, particularly when the practice of smoking ships, for the purpose of destroying rats and other vermin, has long been adopted, and with partial success. The destruction caused by rats on board ship is only second to that effected by the white ants. Instances have been known of their eating through a vessel's bottom and decks; while their ravages on the stores, provisions, and cargo are almost incredible. Nor are these the only vermin with which ships in this country are infested. The cockroach and black ant, centipede, &c. if not destructive of the vessel itself, are so of the comfort of every person on board. The first find their way more or less on board every ship in India; the second prevail at times to an extent almost surpassing belief, on vessels trading to the eastward, which supply themselves with wood in the Straits. The application of steam to the destruction of these latter animals is of itself an advantage almost incalculable. It is obvious, that nothing but the most searching, and, at the same time, powerful agent, could extirpate an animal like the common ant. The experiment was first tried in England, at the suggestion of Captain Ford, late in command of the ship Providence in this port, on a ship belonging to him, and we understand with success. We believe that the steam was not applied to the utmost extent of its power on that occasion. It has, however, since, on the representation made by Captain Ford of the success of the experiment in England, been applied to perhaps as great an extent as it could be with safety; and certainly to sufficient extent for all practical purposes, with the most complete success: since that experiment too it has been applied on several other occasions.

The first trial in this country was on the Honourable Company's ship Investigator. The experiment was conducted by Captain Forbes, of the Bengal Engineers, and Mr Kyd, the Honourable Company's Master Builder, and, as might be ex-

pected in such hands, would appear to have been managed in the detail with the utmost care and attention, affording a secure guide for future operations. The following is an extract from their able and interesting Report:—

"1. We had the Honourable Company's Steamer Irrawaddy moored alongside the Investigator; and having fitted two lead pipes furnished with stopcocks to the head of the Irrawaddy's boiler, by means of a new manhole cover, we led the pipes into the Investigator, and put them down the fore and after hatchways into the hold.

2. We had, in the meantime, closed the scuttles of the Investigator's sides, as well as all the hatches; moreover, the stern and gallery windows, and the entire front of the poop; boring at the same time a hole in each gallery cell, to allow the steam to come up from the hold into the cuddy.

3. We also fitted a pipe, having a stopcock on it, to the main hatchway, which was opened occasionally to observe the state of the steam, in case of danger, from its over-pressure.

4. These preparations being made, we had the fires of the Irrawaddy's boiler lighted at 11 A. M. on the 7th ultimo, so as to let on the steam at noon the same day; by six o'clock the same evening, the steam began to show itself at the scuttles, and at the hatches; and the poop and upper deck began to feel hot. We continued the steaming for forty-eight hours, by which time the whole of the decks and sides even to the outside copper, close to the water's edge was so heated, as to be scarcely touchable by the hand.

5. On opening the hatches to ascertain the result of the operation, we were pleased to see the effectual manner in which the penetrating heat of the steam had destroyed the vermin. The white ants appeared reduced to a substance like soap, and the cockroaches and rats to a soft pulp, capable of being washed down into the limbers.

6. The putrid smell of animal decomposition came on at the end of twenty-four hours, but did not continue above a day.

7. The paint on the beams and sides was shrivelled, and peeled off, and the leather which covered the ring bolts in the cuddy, was converted into charcoal.

8. We have purposely delayed sending in our Report, till

we could ascertain the effect of the steaming on the caulking, a matter regarding which we were anxious, inasmuch as, if that had been disturbed, the operation would in future have had to be confined to a ship about to undergo repair in dock. We have, however, satisfaction in being able to report, that we can discover no injurious effect on the caulking; further, that the steaming a ship for the destruction of vermin seems perfectly feasible, either afloat or in dock, whether about to undergo repair, or to proceed to sea. The only circumstance demanding attention in the latter case is, that the ship will require new painting.

9. Although the destruction of vermin by steaming may be resorted to under all circumstances, yet the steaming of vessels in dock, previous to their undergoing their usual quinquennial repair of caulking and coppering, will be the most desirable.

10. In addition to advantages already noticed, the facility of introducing the steam from below, and the absence of condensation by the water, in contact with the whole surface of the immersed bottom, when afloat, will enable the steam to effect its object in one-third less time.

11. The present experiment having enabled us to ascertain an efficient and simple method of steaming ships, to destroy vermin, we beg here to record our opinion, that in all moderately large ships about to be steamed, the masts and bowsprit ought to be taken out, as also all projecting boomkins, davits, and cat heads. The whole of the hammock stantions and external birthing should further be taken away, and the ship be cleared of all lumber, and articles likely to sustain injury from the steam.

12. For large ships, where the unmasting would be laborious, we conceive that long bags made of painted canvass, might be put over the mast heads, and nailed to deck, and the steam admitted into them. Painted canvas also might be tacked with wooden battens to the deck, and to the outside, enclosing the sides all round, and this might be extended to hawse chocks, quarter galleries, and to all parts which it would be inconvenient to remove.

13. By lifting the ship's pumps about three feet, one of them may be fitted as a safety steam valve, and the other as a safety air v[illegible] [illegible]s a communication be made quickly

with the lower part of the hold. The steam pipes should be long enough to introduce the steam into the bottom of the hold, as otherwise the steam and heat would be for a long time intercepted from the lower parts of the vessel, by a stratum of air.

14. Such of the steamers as may be intended to be used for steaming ships, might conveniently, and at small expence, be provided with a spare boiler manhole cover.

15. The whole apparatus for steaming could easily be transferred to any one of the steamers, and would then be available for any ship. Independent of the manhole cover, the parts would merely consist of two pipes of copper (fitted with stop-cocks) of five inches diameter, together with a steam safety valve pipe, and an air safety valve pipe, for the ship about to undergo the process. *

16. In steaming ships afloat, it will obviously occur to hang the steamer on to the vessel to be steamed, and then so to secure the two, as to prevent the cross motion their being separately moored would cause, to the injury of the steam pipes. For steaming ships in dock it will be requisite to have a boiler set so near to the dock, as to admit of having pipes fitted for the conveyance of the steam to the ship.

17. It will be requisite, when the steam has been admitted into a ship, whether it be afloat or in dock, to have a cauldron of boiling water ready to kill insects which may try to escape; and it will be requisite to have a few persons in attendance, to shut up places where steam shows itself, as well as to attend to the state of the pipes, and of the operation.

18. We come now to the consideration of the vast importance to shipping in tropical climates, which this successful experiment of steaming of ships, to destroy white ants, has indicated. The speedy riddance of rats, cockroaches, centipedes, and scorpions, would alone be of importance. The waste of property by the two first is very considerable, and fumigation is frequently employed to get rid of them: smoking is dangerous, inasmuch as many ships have been burned in the process, but although smoking kills rats, it will not kill cockroaches nor ants; neither has it the slightest destructive effect

* Partial condensation, such as in the case of the Investigator, led to the fracture of the upper deck pillars, would by these valves be effectually guarded against.

on their eggs, so that while the larger tribe of noxious animals may be got rid of by this means, the smaller and much more dangerous ones, the white ants, are left to destroy the ship.

19. Sinking is no doubt an effectual measure for the extirpation of those insects, but it is one which can be resorted to only in small ships, and in them even at a considerable risk of entire loss, and at considerable expence, a great waste of time in the employment of the vessel, and the disadvantage of laying a foundation, by the introduction of mud, for a future, more successful attack. In fact, it has invariably been found, that vessels which had been sunk to kill white ants, were speedily infested afterwards, and rapidly destroyed.

20. The being enabled to eradicate white ants from Indian ships, must have the effect of giving an enhanced value to this description of property. It is on record, as well as a truth familiar to the officers of the Marine Department, that several Government vessels have been entirely destroyed by white ants; and further, that by their ravages great public loss has been sustained: under such circumstances, too much cannot be said in favour of such an application of steam.

21. The success of the present experiment may form an era in the history of Indian shipping. The steaming of vessels, to destroy vermin, must speedily come into general use. Then the only wonder will be that, seeing the common application of steam to almost every purpose, its excellence as a substitute for fumigation was not *in this country* sooner suggested."

It is scarcely necessary to add a word to the above clear detail. The expence of the operation, including the requisite pipes, &c. did not amount to Sicca Rupees 800, and the subsequent charge for cleaning the ship was about 100. A complete apparatus to be attached to the boiler, it appears, would not cost above Sa. Rs. 1500, after which the expence would be confined to the expenditure of the coals, and the necessary artificers and contingent charges One precaution, however, would appear to be necessary to be adopted in the steam vessel, which is, to take care that none of the vermin find their way from the vessel steamed to the steamer. Such appears to have been the case with the Irrawaddy.—*Gleanings in Science*, No 4, pp. 104–109. *

* This i llent scientific journal published at Calcutta. —Ed.

Art. XX.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

I. *The Article* Ship-Building. Published in Vol. xviii. Part I. of the *Edinburgh Encyclopædia*. Edited by Dr Brewster.

The publication of this able and comprehensive article is likely to awaken a great degree of attention to the much-neglected art of ship-building, embracing as it does so wide and so general a view of a subject so intimately connected with the welfare of our beloved country. The author of the paper most properly observes, that in no period of the world has the subject of naval architecture had higher claims on public attention than the present, and to our own country in particular, it is an art of such transcendant importance, that no means should be left untried to give it every perfection of which it is susceptible. Nor is it only in a commercial point of view that ship-building is valuable to man, since by the enterprise that fortunately characterizes the modern navigator, the ocean is become one of the high roads of civilization,—perhaps the highest; and, therefore, in the successful cultivation of the various arts connected with navigation and commerce, every lover of human improvement must feel an interest proportionate to the influence which they are now universally allowed to exercise on the improving destiny of man.

Naval architecture, continues the author of the paper, may be contemplated under three capital points of view. *First*, as regards the means it affords for the purposes of war; *secondly*, as it relates to commercial enterprise and speculation; and, *thirdly*, as it is connected with human improvement, the enlargement of geographical knowledge, and the extension of the blessings of civilization. The cultivation of the first is unfortunately rendered necessary by the peculiar condition of the world, and perhaps the second and third are in some degree assisted by it; but it is the successful advancement of the latter that renders the study of naval architecture most pleasing, and elevates it to a rank with those arts which minister so essentially to the happiness and well being of man.

The author of the article under consideration has contemplated his subject in the most general points of view. Omitting the early history of the art, the materials for which are abundantly supplied by Charnock and others, he advances at once to its leading and essential elements, and connects in a comprehensive form the labours of Bouguer and Euler, with those of Atwood, Chapman, and Seppings. Ship-building, though an imperfect art, has many great and celebrated names connected with its history. Assuming, for the first time, in the latter part of the seventeenth century, a scientific form, in consequence of the labours of Paul Hoste, in his *Theorie de la Construction des Vaisseaux*, we find it afterwards enriched by the labours of many mathematicians; and the masterly improvements of Seppings in our own times, has added to it a perfection it never before possessed. The creation of the College of Naval Architecture in Portsmouth Dock-Yard has also communicated to it a great impulse. It cannot *now*

be said, to adopt the language of the author when speaking of its former condition, that the torch of geometry does not illuminate its path, or that the maxims of mechanical science are not applied to its daily practice. Inquiry has been awakened, and the antiquated rules which formerly guided our ship-builders are now gradually giving way to methods authorized by the legitimate deductions of science. It is a mighty and comprehensive problem to contemplate all the essential elements connected with the construction of so massy and stupendous a fabric as a ship destined for all the terrible purposes of war,—which, in the magnificent voyages it undertakes, has to cross wide and immeasurable seas, agitated at times by the unbridled fury of the wind, subjecting it to strains of the most formidable kind;—which shall possess mechanical strength to resist these, and at the same time be adapted for stowage and velocity,—which is expected in all cases to overtake the enemy, and yet must contain within it the *materiel* for a six months' cruize. These, and many other complicated inquiries which the naval architect has to contemplate, must all be involved in the general conditions of his problem, the elements of which he must estimate while he is rearing his mighty fabric in the dock, and be prepared to anticipate their effects when he launches his vessel on the turbulent bosom of the sea. And yet there are men, blind to the experience of the past, who deny that science has anything to do with the construction of a ship. Science, says the eloquent author of the article, is the basis of every well ordered machine. Science was the ground work of all that Watt, Smeaton, or Wren, ever achieved; and can science, says he, be unnecessary in the formation of a ship? We must say in reply, that science is absolutely necessary in the construction of a ship; and we cordially agree with the writer, that the college of naval architecture is likely to prove a most beneficial institution to the country. In the year 1795, we find that the commissioners appointed to revise the civil affairs of the navy, remarked, that the class of persons from whom the master ship-wrights and surveyors of the navy were chosen, "had no opportunity of acquiring even the common education given to men in their rank of life, and that they rise to the complete direction of the construction of ships, on which the safety of the empire depends, without any care or provision being taken on the part of the public, that they should have any instruction in mathematics, mechanics, or in the science or theory of ship-building." The death blow to this lamentably imperfect system was, however, given by the establishment of the college.

Our author has given a forcible outline of the course of studies pursued at this admirable institution.* After a severe contest before admission, the successful candidates remain seven years at the college, pursuing geometry, algebra, and trigonometry, in all their important applications, examining the theoretical and practical details of mechanics and hydrostatics, and closing their purely mathematical inquiries by an enlarged course on the differential and integral calculus. After obtaining sufficient elementary knowledge, they are employed in constructing original designs

* We have reason to know that the author of the article is totally unconnected with the college.—Ed.

of ships of war, ascertaining their displacements, the centres of gravity of their displacements, and of the whole masses of the ships and their equipments, considered as heterogeneous bodies. To this is added the most exact and accurate inquiries connected with the stability, both according to the metacentric method of Bouguer, and to the more perfect and precise investigation of Atwood. Comparisons are also instituted,—the qualities of English ships are compared with those of a foreign build—their several properties are analyzed—the good qualities are combined so as to remedy the bad, and to produce in their ultimate application the most perfect design.

But it is not to theory only, continues our author, that their attention is directed. The practical details of the art receive a large proportion of their attention. They are effectually taught how to lay off ships in their practical construction, and in making the drawings which are necessary for the execution of the work in the progress of the building. The adze and the line are put into their hands, like the humble operative at the dock-side, and a vigilant practical ship-wright examines into the minutest details of their duty. Engaged, therefore, in the morning, we will suppose, in studying the theory of their profession—in calculating the displacement—in investigating the properties of the midship section—estimating the power and influence of the sails, or endeavouring to catch a glimpse of the deep and recondite laws that regulate the resistance of fluids,—they turn in the afternoon to the practical details of their art—in shaping and adjusting timbers—filling up the component parts of Seppings' diagonal framing—bolting together the timbers of his circular sterns, and observing in those numerous cases which the eye of theoretic intelligence is in general so ready to catch, the actual application of rules which occupied their morning thoughts. What else, our author asks, is necessary to make a complete and perfect ship-wright? The members of the college have the amplest and best theories continually before them, and the most enlarged practice to exemplify their application.

Our author, however, closes this part of his paper with an admonition, which will not, we hope, be neglected in the proper quarter. The studies of the members of the college, says he, are but begun, when the term which marks their residence has expired. *Naval architecture is a jealous mistress*, and requires the undivided man. Not the devotion of a few years, but of a life consecrated to its pursuit; year after year, with unwearied zeal, must be devoted to its interests; and the cordial and uninterrupted pursuit of its varied details must meet with that reward which attends the industrious labourer in other departments of the arts.

We are glad to find, however, that our author, notwithstanding his able and vigorous defence of the college, has not neglected to consider the condition of the working men. Among the many operatives which a dock-yard presents, says he, there must be some few at least deserving of a better fate, than to spend the long term of their lives in a perpetual state of unceasing labour; some, though working at first as humble ship-wrights, yet deserving from their talents to rise to command. The great object, says the author, in a well regulated community, is to encourage ability wherever it

appears; and we are persuaded that the welfare of the country will be essentially promoted by fostering native talent.

We particularly admire the clear and methodical method adopted in the article, of applying the method of equidistant ordinates to the computation of the displacement and other kindred inquiries. The tabulating the different systems of ordinates, and expressing the solidities of the sections in intelligible mathematical forms, makes the long train of calculation both easy and convenient. In investigating the general question of stability, the author has properly adopted the rigorous method of Atwood, and, after investigating its theoretical conditions, follows that profound mathematician in applying its principles to bodies of different forms, finding the centres of gravity of their entire volumes, and of the volumes immersed; calculating the area of the section of the displaced volume, and the length of the line representing the measure of the body's stability; and finally, computing the equivalent effect of the wind acting on the sails at some given distance from the axis of the body. And, lest there should be any of the readers of the *Encyclopædia* not versed in the flowery and delicate calculus of the sines, or capable of applying the immortal discovery of Napier, he has added the excellent experimental illustrations of Beaufoy, all of which tend to confirm, as they ought, the former results.

The method of Atwood for computing the stability is rigorous and exact, but excessively laborious; and therefore the author properly remarks, that, in cases where a great accuracy is not required, the metacentric method of Bouguer may with propriety be adopted. In applying the two methods to a seventy-four gun ship, the author found the following results,

By the method of Atwood the stability at an angle of ten degrees is represented by	Tons. 2115.9,
and by the method of Bouguer	2135.4,

the metacentric stability differing from the true stability only 19.5 tons, or about 1-108th of the whole quantity.

There are some chances of error, however, in the application of the metacentric mode, which the author has properly referred to, and we join with him in cordially recommending the method of Atwood, notwithstanding its long calculations.

In investigating the position of the centre of gravity, he illustrates it by theoretical considerations, by actual computation, and how the same may be performed experimentally. He gives a neat practical rule, which we transcribe. "*Divide the difference of the momenta of the inclining forces by the difference of the same forces, and the result will be the distance of the centre of gravity of the ship, from the centre of gravity of the displacement.*"

We regret that our limits will not permit us to follow him through his investigation of the effect of the total force acting at the centre of gravity, on the pitching and rolling of a ship,—two considerations of great importance in the structure of a vessel. Nothing, as Chapman observes, is more difficult than to construct a ship, so as to unite the qualities of sufficient stability and easiness of rolling, and the difficulty is very much increased in the constru f merchantmen.

On the my ficult subject of the resistance of fluids, the

author has followed the steps of Chapman, that ingenious man, though possessing much less theoretical skill than Euler, Bernouilli, Condorcet, or D'Alembert, yet, from being more conversant with the actual conditions of a vessel when sailing through the waves, being more likely to have attained results more consistent with truth, than those laborious, but too often speculative forms, produced by the before-mentioned illustrious men. And yet there is every thing about the resistance of fluids, to invite the enterprise of the most ardent geometer to a still farther investigation of this deep and recondite question. Independently of the intellectual renown which would be obtained by the man who shall place this beautiful inquiry in a clearer and more satisfactory point of view, who, not seduced by the images of his analytical creation, is content to blend the sober results of experiment with those powerful operations of his calculus, which enable him so often to penetrate the obscure mysteries of nature,—there is an immense practical value attached to the inquiry, which few other branches of philosophy possess. Harvey long ago remarked, in the *Annals of Philosophy*, "that, had the subject been one which *individual* industry and sagacity could have successfully prosecuted, there can be no doubt but its complete solution would have been long ago achieved, or at least some large and important steps made towards its completion. The problem" says he "is one which involves too many difficulties for any individual to contend with, unless that individual possessed talents of the very highest order, uninterrupted leisure, and the necessary command of money,—three elements," says he, "not often combined in the same person; and as the past has not afforded a fortunate example of the kind, we may almost fear the future will not be more propitious." Inman, the learned professor at the College of Naval Architecture, remarks also in the notes to his translation of Chapman, "that it is difficult to draw from the theory of resistances, as it now stands, any particular conclusions applicable to ship-building. The author of the paper, however, having adopted the investigations of Chapman, has applied them to the actual circumstances of a ship, and deduced the area of a plane whose resistance is equivalent to that of the vessel when moving with the same velocity.

The portion of the paper devoted to the sails of ships might, with much propriety, have been extended. This is a subject quite in its infancy, and we fear that sail-making and ship-building have not hitherto enjoyed the intimate connection which they ought. The inquiry is confessedly a difficult one, like most others relating to naval architecture, particularly in the case of merchant ships, which present the most remarkable anomalies. These anomalies owe their origin to the variable specific gravities of the cargoes; so that the same ship in different voyages must present different values for the movements of stability, and therefore equally varied results in the efforts of the sails.

The section on the dimensions and forms of ships is one replete with the most interesting inquiries. The gradual augmentation that our ships of war have received in their dimensions is connected with the most interesting and important principles. A first-rate constructed a century ago,

is a vessel of quite a different class from a first-rate of the present day. Of such magnificent ships as the Britannia, the Prince Regent, or the St George, our forefathers could have had no conception. They are not only magnificent, as exhibiting the mightiest combination of timbers ever constructed by man, but in future wars will develope energies more terrific than any exhibited at St Vincent or Trafalgar. The Regent of 1000 tons constructed in the reign of Henry the Seventh, can bear no possible comparison to the Regent of 2600 tons, constructed in the reign of George the Fourth. Spain was the first nation that increased considerably the dimensions of her different classes of ships, and France followed her example with better success. In later times the Americans have made some great steps in this important inquiry; and we rejoice to find that our own excellent naval administration have not lost sight of the subject. There are many advantages resulting from the enlargement of the dimensions of ships. It enables them to possess great stability, and thereby to carry a great press of sail, with a comparatively small body immersed in the water; thus giving them a great moving power in proportion to the resistance they experience, and thereby increasing their rate of sailing. Large dimensions also in proportion to the number of guns gives fine quarters to the men in action. It enables a finer form to be given to ships below the water, so that they may have a good entrance forward, and a clean run aft to the rudder, and to have the form best calculated to present great lateral resistance to the water, which prevents the ship from making much leeway.

The only objection to this increase of dimension is the expence; and possibly there are some limits beyond which it cannot be carried. We are persuaded, however, that this limit has not yet been attained, and we earnestly press its consideration on our naval engineers.

We were glad to perceive that the author of the paper had included in his inquiry the masterly tables of Chapman, particularly those derived from the celebrated work of that author on *Ships of the Line*. Chapman appears to have combined many rare and important qualities. Without possessing the profound mathematical knowledge that distinguishes some of the continental writers on ship-building, he was enabled to communicate to his scientific investigations a double value, from the practical aspect he gave to them. The method he pursued was clearly that taught by our immortal Bacon; and the success that attended his labours is manifest in his writings. The writer of the article has many judicious and very important observations on the analytical methods adopted by Chapman,—on the numerical coefficients he employs to connect the various elements of his inquiry together,—the length with the breadth and the displacement,—the ingenious formulæ he employs for deducing the exponent of flotation,—the exponent of the main sectional area,—the moment of stability,—connecting, in a word, the remotest element of a ship, with some primitive and fundamental element on which the whole inquiry depends. There is something exceedingly ingenious in Chapman's attempt to deduce all the elements of a ship from the weight of the guns, and the distance

of their common centre of gravity from the load water line. Thus denoting the number of guns by A, he finds

that the number of the crew may be represented by $3.763\ A^{\frac{5}{9}}$,
the weight of the crew by - - $10.16\ A^{\frac{5}{9}}$,
and their mechanical effect by - - $15\ A^{\frac{5}{9}}$.

In like manner he represents by the formula $18\,k\,A^{\frac{5}{9}}$, the provisions for k months, and water for half the time. The displacement he likewise connects with the weight of the guns, and ascends from thence to the stability,—to the areas of the load water section, and of the main section of the vessel,—to the position of the centre of gravity of the vessel, and even to the movement of the sails;—thus connecting every element of the ship with the primitive element assumed.

There are some, we can readily imagine, who will deny the possibility of tracing all the elements of a ship to a primitive element, and to such we would recommend the strong and forcible observations of the author of the article on this most important point, and also the diligent study of Chapman's Tables. We readily grant that the coefficients and exponents by which the Swedish engineer has endeavoured to connect together the elements of his inquiry, may in some, or even in many cases, be erroneous. They may have been deduced from observations on too limited a scale to permit us to draw in every case those general conclusions which are so desirable; but we quite agree with the author of the article, that a digest of the properties of some of the best ships of the British Navy, conducted according to Chapman's principles, would be productive of most important results. In no subject, says our author, is there greater room for the application of the most rigid principles of the inductive logic. Millions of ships have been constructed, but only here and there a successful example has been offered for our contemplation, as if to mock the implicit obedience we pay in the practice of naval architecture, to uncertain and ill-defined rules.

One of the most important and valuable portions of this paper is that devoted to the arching of ships. In every point of view in which the general problem of arching can be contemplated, it will be found to involve considerations of the highest importance to naval architecture. Owing its origin to those peculiarities of form which the complicated conditions of stowage, stability, velocity, and general sailing qualities render necessary; it has been a great object with the naval engineer to preserve to the *floating* vessel unimpaired those essential properties of form which he endeavoured to impart to her in the process of *building*. Constructed as ships are of timber of the most varied dimensions and forms,—disposed in directions of so many different kinds, and subjected to strains so changeable in direction and quantity, it may be fairly said, that, next to the original determination of the best form, the skill and intelligence of the ship-builder may be measured by the degree in which the tendency to arching may be diminished.

To discover the law, observes the writer of the paper, which influences a ship, whether laden or unladen, when floating quiescently in water, we may suppose the vessel to be divided into vertical sections of an indefinite-

ly small constant thickness, perpendicular to a vertical longitudinal plane. If we commence our consideration at the stern, and advance gradually forward, it is evident that the sections comprising the counter and its connecting parts, being free from the water, will be subject to no reaction from it; and when at last any reaction does take place, it must at first, from the peculiar form of the body, be infinitely less than the weight of the section whose displacement occasions it. As we approach, however, the midship section of the vessel, the upward section of the fluid will approach more and more to an equality with the weight of its corresponding section, and ultimately become equal to it; and if we pass beyond this section, and which may be denominated the section of hydrostatic equilibrium, we shall find the weight of the water displaced become greater than the weight of the section above it. In like manner, if we commence at the bow of the vessel, we shall find a similar section of hydrostatic equilibrium, and afterwards a like increase of the weight of the water displaced above the weight of the section reposing on it.

Dupin, in his paper *Sur la Structure des Vaisseaux Anglais*, has given a fine analytical view of the subject; and has furnished the differential equations on which the whole problem of arching depends. Our limits will not permit us to follow the analytical steps of this beautiful inquiry, and we can only furnish the following theorems resulting from them.

I. *That when a vertical plane divides a vessel into two parts, so that the weight of each part is equal to the weight of water displaced by it, the moments of those parts estimated in relation to the same plane, to produce what is denominated arching, will either be a maximum or a minimum.*

II. *That this effect will be a maximum when the infinitely small section contiguous to the plane of the moments has its own moment in a contrary direction to that of the total moment.*

III. *That the effect will be a minimum when this section has its own moment acting in the same direction as the total moment.*

These theorems are applied by Dupin to the distribution of the forces operating on the hull of a seventy-four gun ship when fitted for sea; the numerical elements relating to the weights and displacements of the several sections being derived from Young's paper contained in the *Philosophical Transactions* for 1814. We regret exceedingly that we cannot lay before our readers the whole of this highly interesting inquiry, but must pass on to remark, that the causes of arching are not due entirely to the unequal distribution of the weight and pressure, but that the longitudinal and horizontal pressure of the water also contributes to this alteration of form. Dr Young has remarked that the partial pressure of the water in a longitudinal direction affects the *lower* part of the ship only, compressing and shortening the keel, while it has no immediate action on the upper decks. The pressure thus applied must obviously occasion a curvature if the angles made with the decks by the timbers are supposed to remain unaltered, while the keel is shortened in the same manner as any soft and thick substance, pressed at one edge between the fingers will become concave at the part compressed; and this strain upon the most probable upposition respecting the comparative strength of the upper and

lower parts of the ship, must amount to more than one-third as much as the mean value of the former, being equivalent to 1000 tons, acting on a lever of one foot in length, while the strain, arising from the unequal distribution of the weight and the displacement, amounts, where it is greatest, that is, about 37 feet from the head to 5260, in a seventy-four gun ship of the usual dimensions; and although the strain is considerably less than this exactly in the middle, and throughout the aftermost half of the length, it is no where converted into a tendency to "*sag*," or to become concave.

To correct these serious alterations of form, has been the great object of the labours of Seppings,—labours which every day affords abundant proofs of their accuracy and truth.

(To be continued.)

II. *The History of Insects*, Vol. I.—Family Library, No. 7.

At no distant period a history of insects would have been regarded as only calculated for those investigators of science whose leisure and peculiar taste fitted them for pursuing or understanding what in the eyes of the multitude might seem to be totally valueless, or at best but an idle amusement. With the exception of the Bee and the Silk Moth, and a few others, little was popularly known of the manners and instincts of those countless myriads of living atoms which crowd every country, and still less of the powerful agency of the insect tribes in the general economy of nature. This agency, which is now becoming matter of daily observation, was seldom recognized, except when the excessive reproduction of particular species in certain regions destroyed the labours of the husbandman, and produced famine and pestilence. Facts, however, have been gradually accumulating in the writings of entomologists, which tend to show that this, the most numerous class of animated beings, exercises functions in nature not less important than many others whose relative bulk precludes our regarding their existence with indifference. The whole tribe of monœcious and dicœcious plants owe their fertility to the agency of the insect tribes; and if attention had been earlier directed to these minute beings, many arts of but recent invention might have been perfected ages before. It has been remarked by a celebrated naturalist, that the hornets composed their dwelling of a species of paper, fabricated on principles exactly similar to those now practised, long before the manufacture of that invaluable article was stumbled upon by human ingenuity; the Tenthredines, or sawflies, cut the branches of trees with their serrated instruments before the saw was used in the arts; and their small but powerful organ has still this advantage over the mechanics' tool, that it combines the properties of a rasp and file with that of a saw. The Wood-boring Bee and the Ichneumons are possessed of an apparatus for boring, from which even human ingenuity may improve their implements destined for similar purposes; and the Termes of Africa build in an incredibly short space of time dwellings of from twelve to fifteen feet high, upon which the pick-axe makes no impression—monuments far more wonderful, and five times

larger, than the boasted pyramids of Egypt, when the size of the animal is taken into consideration. And when to all this is added the wonderful mechanism of their minute organs,—the evidences of design in their still more wonderful transformations and their instincts,—one is not surprised at the assertion of the first entomologist of Europe, (M. Latreille), that the wonders of insect structure—the concentration of organs so minute and susceptible of so many different sensations in such an atom of matter, heightened his admiration of the Supreme Intelligence far beyond what the contemplation of the structure of the most gigantic animals could inspire.

The History of Insects in the FAMILY LIBRARY, from its popular form, is calculated to spread a taste for the study of entomology among readers to whom the details of the more scientific naturalists might at first possess no attraction. A similar work on *Insect Architecture*, in the *Library of Entertaining Knowledge*, will aid the volume before us in spreading a taste for scientific information still wider; and we hail with pleasure the exertions of those learned men who, by works such as the present, show how much may be done for science by simplifying its details so as to extend its range. The Institutions for the instruction of workmen and their success, has demonstrated that a vast portion of physical science, hitherto shut up in volumes destined for the learned, may be placed within the reach of ordinary readers, and much that is generally useful in connection with the arts of life, successfully taught even to the unlettered mechanic. The *Library of Useful Knowledge* led the way in this country in placing science within the reach of the poor; and the numerous *Manuels*, *Resumés*, and *Precis* of all the sciences and arts which teem from the press in France in a compressed form and low price, show that an extensive, and, we hope, a happy change has taken place in regard to the desire of scientific instruction. The writers of most of these popular treatises too, in both countries, are men of known talent, versant in the subjects upon which they write; and, while instruction is conveyed to the mass of the community in a simple and intelligible form, the more learned are satisfied that the materials are the result both of extensive reading and observation.

Among the sciences thus thrown open to all classes, Natural History has long appeared to us as that branch which, beyond every other, is calculated not only to captivate the young of both sexes, and to improve their powers of observation and reasoning in a high degree, but to open the way for the successful pursuit of the other sciences. All the materials of commerce and the arts are derived from objects with which it is the business of natural history to make us acquainted; all the conveniences and necessities of man are supplied from the same source; and the moral tendency of such studies is so palpably evident, as to make it matter of surprise that a general knowledge of external nature has not ere now formed part of the elementary instruction in schools for the young.

But to return to the history of Insects in the volume now before us. No systematic plan seems to be adopted in the arrangement of the orders, which may have appeared superfluous in a book intended for general readers. The volume commences with the history of that useful insect the Hive Bee, in

which all the information to be derived from Reaumur, Huber, &c. is agreeably detailed. This is followed by an account of the Humble Bee, and some other species, which, from the mode in which they form their dwellings, have been named the Carpenter, Mason, and Upholsterer Bees. Much that is curious concerning these little artisans has been culled from the stores of scientific writers, which must be read with interest by those to whom this branch of science is new. Then follow the Wasps, and the wonderful republics of the Ants, detailed with the same interest, and in the same tone of good feeling by which the whole is characterized; and the volume concludes with the history of some caterpillars, and their mode of forming their retreats previous to their transformations. As the best recommendation of the work, to which we wish all possible success, we give an extract, containing some curious particulars of the Dragon-fly, so common near all our marshes in the summer months.

"Another and a most destructive enemy of the living insect is the tribe of *libellula*, or dragon-fly, a name which they well merit from their voracious habits.

"The French have chosen to call them 'demoiselles,' from the slim elegance and graceful ease of their figure and movements. But, although their brilliant colouring, the beauty of their transparent and wide-spread wings, may give them some claim to this denomination, yet they scarcely would have received it had their murderous instincts been observed. So far from seeking an innocent nurture in the juice of fruits or of flowers, they are (says Reaumur) warriors more ferocious than the Amazons. They hover in the air only to pounce upon other insects, which they crush with their formidable fangs; and if they quit the banks of the rivulet, where they may be seen in numbers during an evening walk, it is only to pursue and seize the butterfly or moth, which seeks the shelter of the hedge.

"The waters are their birth-place; their eggs are protruded into this element at once, in a mass which resembles a cluster of grapes. The larva which comes out of these eggs is six-footed. The only difference between the larva and nymph is, that the latter has the rudiments of wings packed up in small cases on each side of the insect.

"In this latter state it is supposed that the creature lives at the bottom of the water for a year. It is equally voracious then as in its perfect state. Its body is covered by bits of leaf, wood, and other foreign matters, so as to afford it a complete disguise, while its visage is concealed by a prominent mask, which hides the tremendous apparatus of serrated teeth, and serves as a pincer to hold the prey while it is devoured.

"Its mode of locomotion is equally curious; for though it can move in any direction, it is not by means of feet or any direct apparatus that it moves, but by a curious mechanism, which has been well illustrated by Reaumur and Cuvier. If one of these nymphs be narrowly observed in water, little pieces of wood and other floating matters will be seen to be drawn towards the posterior extremity of the insect, and then repelled; at the same time that portion of its body will be observed alternately to open and shut. If one of them be placed in water which has been rendered turbid by milk, or coloured with indigo, and then suddenly removed into

a more limpid fluid, a jet of the coloured water will be seen to issue from the anal extremity of the libellula, to the extent sometimes of several inches; at the same time the force with which the column is ejected propels the insect in the opposite direction, by virtue of the resistance with which it meets. Hence it appears that it is by means of its respiratory system that the creature walks—a strange and anomalous combination of functions in one organ.

"If the insect be taken out of the water, held with its head downwards, and a few drops of that fluid poured on its tail, that which was a mere point will immediately open and display a cavity; at the same time the body of the insect, which was before flat, will be observed to be enlarged and inflated, and if held up to the light, semitransparent: moreover, something solid will appear to be displaced by the water, and driven towards the head. This solid mass will shortly descend, obscure the transparency of the lower portion of the body of the insect, lessen its diameter, and, when it does so, a jet of water will issue from the vent. It is clear, then, that the abdomen of the libellula is a syringe, the piston of which being drawn up, of course the pressure of the fluid fills up the vacuum, and, when pushed down, expels the water. To ascertain the fact, Reaumur held the insect in his hand, and when he saw its body inflated, cut it immediately with a pair of scissors, and found it unoccupied with solids. He watched when the jet of water was expelled in another, and as soon as the body was darkened and lessened in diameter, he clipped it, and found the cut portion occupied by solids. There is no doubt, then, that the abdomen contains a moveable piston, and this piston is composed of the air tubes. There are four of these longitudinal trunks. They terminate in innumerable smaller ones, and, according to Reaumur, perform the functions of respiration, as well as locomotion, in the ways detailed.

"After the voracious creature has lain in ambuscade devouring the larvæ of the gnat and other aquatic insects, till its appointed hour of change, it leaves its natal element for the shore, to undergo its last metamorphosis: for this purpose it usually fastens itself to some friendly plant, and begins the important process which is to convert an aquatic animal into an inhabitant of the air,

"Any person who should at this period choose to seize a number of them, and, taking them into his chamber, fix them to a bit of tapestry, would be rewarded for his trouble by witnessing the conversion of an aquatic into an aërial insect.

"It may easily be seen by the eyes of the nymph whether it is about to change its form; for, instead of remaining tarnished and opaque, they suddenly become transparent and brilliant. This change is owing to the visual organ of the perfect insect, which is amazingly lustrous, shining through the mask of the nymph. If the eye of the nymph be removed, that of the perfect insect may be seen beneath. As soon as the nymph has fixed itself to any object by means of its claws, the first sign of the commencing metamorphosis is a rent in the upper skin, extending along the corslet to the head. When it approaches this latter part, another rent, perpendicular to the first, runs across the face from eye to eye. These

rents are brought about by a power which the insect possesses of inflating its body and head. This last organ, ultimately destined to become fixed and solid, is at this period capable of contraction and dilatation, like a membrane.

" The head and corslet being exposed, the legs are drawn out from their nymphine cases. At this period every part of the insect is soft. After having protruded itself thus far, it hangs with its head downwards, and remains motionless, so as to lead the observer to believe that the efforts which it had hitherto made had exhausted its strength, and that it had thus perished in the act of being born. However, it remains in this position just so long as to permit its body and limbs to be hardened and dried by the air, and then reverses it, forming an arch ; this enables the insect to draw out its tail from the mask.

" When it has just cast off that tenement in which it had till now existed, the body of the libellula is soft, has not attained its full length, and the wings are still folded. It remains, therefore, tranquil and motionless till these important operations have taken place, which are finished, sooner or later, according to the heat or moisture of the atmosphere. The operation may be completed in a quarter of an hour, or take up several hours, according to circumstances. The wings unfold themselves in every direction ;—it is supposed that this curious mechanical effect is brought about by means of the fluids, which rush into and distend them ; for they remain drooping as wet paper if the insect die in the act of metamorphosis ; so that something more than drying is necessary. During the time that the wings, from being shrivelled and flexible, are becoming firm and glistening as talc, the dragon-fly takes care not to allow even its own body to obstruct their expansion in the proper direction, and for this purpose bends it from them ; for if they took a wrong fold at this moment, they would for ever retain the deformity. Provision is even made to prevent the wings from coming in contact with each other ; for, instead of being all in the same horizontal plane, as they subsequently are, they are perpendicular to the insect, and thus ranged side by side."

We have only to add, that the volume is got up, like all the other volumes of this popular Family Library, in a style of great neatness, highly creditable to the publisher, and that the wooden cuts by which the subject is illustrated, possess all the sharpness of copper engravings.

III. *Elements of Practical Chemistry, comprising a series of experiments in every department of Chemistry, with directions for performing them, and for the preparation and application of the most important tests and re-agents.* By DAVID BOSWELL REID, Experimental Assistant to Professor Hope, Conductor of the Classes of Practical Chemistry in the University of Edinburgh, &c. &c. &c. 1830, 1 vol. 8vo. 552 pp.

THE author of the present work has been advantageously known to the public by an excellent popular Treatise on Chemistry, in 2 vols. 12mo, and by a pamphlet explanatory of his improved scale of chemical equivalents, in which hydrogen is taken as a standard of comparison. Since the pub-

lication of these works, he has been professionally occupied as a Lecturer on Chemistry, and a Superintendant of Chemical Manufactories, and more recently he has been called to the situation of Experimental Assistant to Dr Hope, and of Conductor of the Classes of Practical Chemistry, which are carried on in the University under the superintendence of that eminent Professor.

In this advantageous position, with the use of the finest materials, and perhaps the most magnificent chemical apparatus in Europe, Mr Reid has enjoyed the best opportunities of acquiring a thorough knowledge of all the processes and manipulations of practical chemistry. These means of information, indeed, appear in various parts of the present treatise, in which a great mass of practical information is well arranged, condensed within moderate limits, and conveyed with much clearness of conception and perspicuity of language.

The immediate object of the present work is to describe a systematic series of experiments, with such minute directions to the student as cannot fail to enable him to perform them himself, and thus to acquire, along with a knowledge of the subject, habits of nice manipulation in the various operations of chemistry. Mr Faraday had previously published an admirable Treatise on Chemical Manipulation, marked with the talent and ingenuity of that celebrated chemist, but a more elementary and detailed work was still wanting for the chemical student.

This desideratum Mr Reid has well supplied. The work is divided into two parts, the first of which embraces a comprehensive and arranged series of experiments on the various chemical bodies which the material world contains. The second part comprehends several important subjects, with which the student should make himself acquainted as he proceeds with the experiments, with a description of miscellaneous apparatus, and other general topics and methods, which require to be studied before he commences the individual experiments.

The following general view of the plan of the work will enable the reader to form some idea of its contents.

Part I. Division I.—*Simple Substances.*
Class I. Simple substances not metallic, and their combinations.
Class II. Metals and their combinations with non-metallic substances, and with one another.
Division II. *Vegetable and Mineral Substances.*

Part II. Class I. Description of an Improved sliding scale of Chemical Equivalents. II. Miscellaneous Apparatus. III. Scales and Cements. IV. Blowpipe. V. Test Apparatus. VI. Electricity and Galvanism. VII. Galvanic Battery. VIII. Acidemetry and Alkalimetry. IX. Method of measuring Specific Gravities. X. Tables of Weights and Measures,—correspondence between thermometers,—freezing mixtures.

There is one peculiarity in this work which, we are persuaded, will be equally useful to the student, and to those who may use it as a work of con-

sultation. The essential characters of all the different substances which are described are placed by themselves at the beginning of each chapter, and printed in Italics, so that the eye can at once command the particular point of information of which it is in search. The work is illustrated with numerous excellent wooden cuts, and with a series of diagrams, constructed on a new plan, for enabling the reader to perceive at one glance the quantities of different materials required for different experiments, the nature of the action which takes place, and the exact proportion of the products which are furnished.

Art. XXI.—PROCEEDINGS OF SOCIETIES.

1. *Proceedings of the Royal Society of Edinburgh.*

23d November 1829.—At a general meeting of the Royal Society held on Monday the 23d instant, the following Members were elected Office-Bearers.

President.—Sir Walter Scott, Bart.

Vice-Presidents.—Right Hon. Lord Chief Baron, Dr T. C. Hope,
The Hon. Lord Glenlee, Professor Russell,
The Hon. Lord Newton, H. Mackenzie, Esq.

General Secretary.—John Robison, Esq.

Secretaries to the Ordinary Meetings.—Rev. E. B. Ramsay,
Dr J. C. Gregory.

Treasurer.—Thomas Allan, Esq.

Curator.—James Skene, Esq. Assistant.—John Stark, Esq.

Counsellors.—James Hunter, Esq. Sir Henry Jardine,
Dr Alison, Professor Jameson,
Sir William Hamilton, Bart. Sir David Milne,
Rev. Dr Brunton, Sir G. S. Mackenzie, Bart.
Dr Brewster, Dr Duncan,
Captain B. Hall, R. N. Professor Wallace.

Dec. 7.—The following communication was read:—

The formation of sound explained on a new principle; with some observations respecting the manner in which sounds are impressd on the organ of hearing. By Mr John Steward, M. R. Coll. Sur. London.

2. *Proceedings of the Society for the Encouragement of the Useful Arts in Scotland.*

June 17, 1829.—The Annual General Meeting of the Society of Arts was held in the buildings of the Royal Institution, Mound.—James L'Amy of Dunkenny, Esq. advocate, Vice-President, in the Chair.

The Report of the Prize Committee having been read and approved of, the President proceeded to deliver the prizes to the successful candidates, in terms of that report and of the minutes of Council, in the following order, viz.:—

1. To Mr James Clark, steeple clock and machine-maker, Edinburgh, the Society's gold medal, value L. 15, 15s. for his description and relative drawing of a method of cutting screws.

2. To Mr George Buchanan, civil engineer, Edinburgh, the Society's silver medal, value L. 5, 5s. for his protracting table.

3. To Messrs James Dowie, boot-maker, Frederick Street, Edinburgh, and Alexander Black, surveyor, Edinburgh, the Society's silver medal, value L. 5, 5s. for their machine for the use of boot and shoe-makers, of which a description was read, and a model presented to the Society.

4. To Messrs George and James Nasmyth, Edinburgh, the Society's silver medal, value L. 6, 6s. for their method of easing the motion of complex pulleys.

5. To Mr James Brodie, Aberdeen, the Society's silver medal, value L. 5, 5s. for his description and drawing of a double-jointed parallel motion.

6. To Mr Alexander Doig, watch-maker, Musselburgh, the Society's silver medal, value L.5, 5s. for his description of the model of a clock pendulum without the crutch.

7. To Mr David Whitelaw, watch-maker, Prince's Street, Edinburgh, the Society's silver medal, value L. 5, 5s. for his description and drawings of a clock pendulum without the crutch, and in which the pendulum receives the impulse directly from the swing wheel.

8. To Mr John Hendersgn, Brechin Don, the Society's silver medal, for his account of a life boat.

9. To Andrew Waddell, Esq. Hermitage Hill, Leith, the Society's silver medal, for his description of a boat or punt for the conveyance of stones and other materials used in the construction of break-waters, &c.

10. To the Rev. George Tough, Aytoun Manse, the Society's silver medal, for his description and model of an apparatus for sweeping chimneys, and preventing the use of climbing boys.

The names of the successful candidates were called over, and the President delivered to them their prizes, with an appropriate address.

The descriptions, drawings, and models of inventions, for which the above prizes were given, were laid on the table and exhibited to the meeting.

Printed lists of prizes offered by the Society for communications given or to be given in betwixt 1st January 1829 and 1st January 1830 were distributed, and ordered to be advertised.

The Committee on Mr Henry's method of applying the band to the pulley to the foot-lathe, not being ready to report, was continued.

The Committee on Mr Aytoun's lighthouse machinery, and on Mr Stevenson's communications relative thereto, gave in their report, which was approved of by the Society.

Professor Wallace exhibited and described his eidograph, an instrument for copying, enlarging, or reducing plans, pictures, &c. for which he obtained the Society's gold medal on a former occasion; and took occasion to point out the superiority, in the accuracy of its work, and the ease of its movements to the pentograph, the instrument hitherto generally used. The Professor, exhibited in great variety, specimens of the work done by his eidograph, with which several scientific gentlemen present expressed themselves highly pleased.

Mr Gourlay laid upon the table a copy of his "Plan for the Improvement of Edinburgh, No. I." which was referred to an open committee to consider and report. Mr Milne to be convener.

Mr Crawfurd of Cartsburn then moved the thanks of the meeting to Mr L'Amy for his conduct in the chair, which motion was carried by acclamation.

The Vice-President then intimated, that the Society would now adjourn till Wednesday, 11th November next, when it would meet again for the next Season.

Prizes for Session 1829–30.

1. For the most useful invention, discovery, or improvement, a medal. value - - - - - 25 sovereigns,
2. For the next in merit, - - - - 20 ———
3. For the third, - - - - - 15 ———
4. For the fourth, - - - - - 10 ———
5. For the fifth, - - - - - 7 ———
6. For the sixth, - - - - - 5 ———

Nov. 11, 1829.—1. A description of an Anemometer, for measuring the velocity of the wind, invented by Mr Alexander M'Coll, Cupar Fife, was read, and a model of the instrument exhibited to the society.

2. A wrought Iron-wire Bed-bottom, invented by Mr George Walker, wire-worker, Leith Wynd, was exhibited, and a description read.

3. A specimen suit and description of Safety Garments for preservation from drowning, invented by Mr Alexander Mollison, Eglinton Street, Glasgow, were read and exhibited, the garments consisting of a jacket and trowsers of cotton cloth, with pieces of cork sewed betwixt and the lining.

4. A detailed description and drawings of an improved mode of forming Taps and Dies for cutting metal screws, of which a notice was formerly made to the society on 20th February 1828, by John Robison, Esq. Sec. R. S. E., were read and exhibited.

5. *Nov.* 25.—John M'Cliesh Esq. of Maryfield, Edinburgh, and William Keith Esq. accountant Edinburgh, were admitted Ordinary Members.

On the recommendation of the Council, the following gentlemen were unanimously elected Honorary Members, viz.:—

Capt. Henry Kater, V. P. R. S.; Capt. Francis Beaufort, R. N. F. R. S.; J. G. Children, Esq. F. R. S. British Museum; George Dollond, Esq. F. R. S.; Rev. H. P. Hamilton, F. R. S. Trin. Coll. Camb.; John Pond, Esq., F. R. S. Astronomer Royal; Rev. W. Pearson, LL.D. F. R. S.; Rev. T. R. Robinson, D. D. F. R. S. Armagh; Professor Hamilton, Astronomer Royal, Dublin; Dr Roget, Secretary R. S. London; Edward Sabine, Esq., Secretary R. S. London; John Barrow, Esq., Secretary Admiralty; Mr Faraday, Royal Institution, London; George Poulett Scrope, Esq., F. R. S. Castle Combe, Wilts; Dr C. R. Goring, Lambeth; Mr Pritchard, Strand, London; Dr Heineken, Funchal, Madeira; Mr Smith, Surgeon, Kingussie; Dr Hancock, America; Robert Brown, Esq., Linnean Society, London; James Mather, Esq., South-Shields.

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Society also unanimously
Members, viz.:—
Williamson, Melrose; Mr Dun-

Cambridge Philosophical Society.

The Rev. Dr Turton, the President, in the Chair.

Professor Airy, containing the calculation of a correction which it is proper to apply to the length of a pendulum consisting of a sphere suspended by a fine wire. The motion of such a pendulum will be somewhat different from that of a sphere *fixed* to a stiff wire, and this correction would affect the last decimal places in Biot's estimation of the length.

Professor Whewell also read a paper on the causes and characters of the early styles of church architecture; and after the meeting gave an account, illustrated by a number of models, of the different modes of vaulting which succeeded each other in the early churches of Germany. The effect was pointed out which results in the construction of churches from this succession of contrivances, combined with other circumstances which arise from the division of the building into three aisles; and it was shown that the adoption of the pointed arch was one of the consequences which followed from the necessary progress of the art of vaulting.

A new Part of the Society's *Transactions* is just published, containing 353 pages and 6 plates. It is intended for the future to publish a Part at the end of each term, in order that communications laid before the Society may be given to the world as soon as possible.

November 30.—The Rev. Dr Turton, the President, in the chair.

Mr Rothman, of Trinity College, read a notice of an observation of the winter solstice at Alexandria, which is recorded in Strabo, and which has hitherto not been understood, from its being spoken of by the author as an observation of an equinox.

Professor Whewell continued the reading of his paper "on the causes and characters of pointed architecture;" and explained the influence of the pointed arch upon the other members of buildings, through which influence the Romanesque style was at last superseded by the very opposite forms of the Gothic. It was stated also that the transition from one of these styles to the other, which took place in England by means of the *Early English* style, was made in Germany by means of a very different one, which may be termed *Early German*. Of this style the characters were given in some detail, and it was remarked that, among these, the invention of the flying buttress was of as much importance to the complete developement of the Gothic style, as that of the pointed arch.

Observations were also communicated by Mr Millar, of St John's College, on the forms and angles of the crystals of boracic-acid, indigo, and borate and bicarbonate of ammonia.

After the meeting, Professor Sedgwick gave an account of the geological structure of the Austrian Alps, illustrated by the representation of a section traversing their chain, and passing from the plains of Bavaria to the Gulf of Venice.

Art. XXII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

OPTICS.

1. *Mr Faraday's Experiments on Flint-Glass for Achromatic Experiments.*—A paper by Mr Faraday was read at the Royal Society on the 19th November, giving a short account of the experiments made at the expence of government to obtain more perfect glass for optical instruments. The paper commenced by stating, that, although glass had been brought to ample perfection for domestic purposes, yet for optical instruments it was far from being perfect. This fact was too well-known; and it was a singular circumstance, that the first telescope maker (Mr Dollond) had not been able to obtain a perfect disc of the circumference of four and a-half inches for an achromatic telescope in the last five years, nor one of five and a-half inches in the last ten years. The want of an improved glass for optical instruments was so much felt, that, in 1825, a committee was appointed to make experiments, in order to ascertain if an improvement could be made. His majesty's government afterwards ordered every facility to be given, and stated, that the expence incurred in the experiments should be paid out of the treasury. A furnace had been erected in the Falcon Glass Works, and subsequently one at the Royal Institution, where the experiments had been carried on with the greatest assiduity. The paper now read was intended as a summary of these proceedings. The experiments gone into were briefly glanced at, and discoveries had been made which had brought the manufacture of glass for optical purposes to nearly a perfect state, the faults so long complained of, viz. of the glass being wavy, reely, &c. being remedied to a great extent. The most perfect homogeneous glass obtained by these experiments was found to act perfectly. The paper went into minor details. The experiments are still going on.

2. *Two Large French Achromatic Object-Glasses purchased by Mr South.*—At a meeting of the Astronomical Society, held on the 13th November, the President (Mr South) announced that he had succeeded in purchasing two of the largest object-glasses that had ever been made. One of them is nearly twelve inches in diameter, the other is above thirteen inches. The first of these object-glasses was mounted as a telescope at the Royal Observatory at Paris, and the French government had expended L. 500 Sterling in the purchase of a stand for it, so colossal are its dimensions; but they were too parsimonious to purchase the object-glass itself, which belonged to the opticians who made it. A private individual, therefore, has in the meantime stepped in and run away with the prize, which the French government affirmed they could not afford to pay for; and it is now about to be set up in Mr South's Observatory at Kensington. Mr South paid a just tribute of respect to our government, (and particularly to the Duke of Wellington,) who afforded him every facility for bringing these object-glasses into the country, not only free from examination at the Custom House, but also free from all duty.

3. *Dispute concerning the Glass of the Great Dorpat Telescope.*—M. Utzschneider has published a *reclamation*, denying that the glass of this celebrated instrument was made by M. Guinand. The Editor of the *Bibliotheque Universelle*, who is particularly charged with having made this mistake, refers to this *Journal* as its authority, viz. No. iv. of our Old Series, p. 305, 1825; so that the force of M. Utzschneider's complaint is directed against us.

We knew well that M. Guinand went to M. Utzschneider's establishment at Benedictbuiern near Munich, to communicate his methods, and to put them in practice. All this he did;—and we know, moreover, that he did possess the art of making very superior glass, as the report of the Astronomical Society of London proves.

With this information we stated, that, by means of glass made by M. Guinand's method, M. Fraunhofer constructed achromatic telescopes far superior to any hitherto made; or, if it shall be thought a better interpretation of our words, we have stated, that, by means of M. Guinand's glass, M. Fraunhofer has constructed such telescopes, &c.

Here there is no statement either direct or implied that the glass of the Dorpat telescope was made either by M. Guinand or by his methods, and we think that the Editor of the *Bibliotheque Universelle* has committed an oversight in throwing the blame upon us.

M. Utzschneider, we presume, will not deny our assertion, that M. Fraunhofer did construct superior achromatic telescopes by means of M. Guinand's glass.

The following are the passages referred to: "The great discovery of a method of making flint glass in large pieces and perfectly pure, and free from striæ, which was made by the late M. Guinand, and of which we have given a full account in this Number, may be considered as forming an era in the history of the Achromatic Telescope.

"By means of this glass M. Fraunhofer has constructed achromatic telescopes far superior to any that have been hitherto made."—*Edinburgh Journal of Science*, vol. ii. or No. 4, April 1825, p. 305.

"Si dans ce meme article, il nous est arrivé de citer parmi les produits du talent de Mr Guinand, l'objectif du Telescope de Dorpat, *ce n'est que parce que cet objectif lui a été attribue par plusieurs journaux*, en particulier, par le JOURNAL OF SCIENCE of Edinburgh. (T. ii. p. 305, 1825.) *Bibl. Univers.* vol. xlii. No. 1, September 1829, page 73.

II. CHEMISTRY.

4. *Oxygen in Lithia.*—A Russian chemist in Moscow has lately found in lithia upwards of 10 per cent. more oxygen than was given by the highest results of Vauquelin, Gmelin, or Arfwedson. By a repetition of his experiments, Berzelius has obtained nearly 55 per cent. for the oxygen in this earth. Berzelius supposes this high result to be owing to the great purity of the lithia transmitted to him from Moscow. The experiments, when published, will be of great interest. J.

5. *Iodine and Bromine in Salt Springs and Mineral Waters in Eng-*

land.—Dr Daubeny of Oxford has discovered *Iodine* in more than one of the Cheshire salt springs, and in several waters containing purgative salts, such as those of Cheltenham, Leamington, Gloucester, and Tewkesbury.

He has obtained *bromine* in a separate state from one of the Cheshire brine springs; and he is of opinion that it is not absent from any of the English springs which contain much common salt, except that of Droitwich in Worcestershire.

Our countryman MrMurray seems to have preceded Dr Daubeny in these discoveries. He long ago discovered iodine in the mineral waters of Cheltenham and Gloucestershire. He also discovered iodine and bromine in the brine springs at Ingestrie six months ago. See his *Manual of Experiments illustrative of Chemical Science.*—See *Ann. of Phil.* September and October 1829.

6. *New principle in Albumen.*—M. Couerbe has discovered a new principle in albumen by exposing to a cold of 32° Fahr., and a few degrees below it, concentrated solution of white of egg. At the end of a month the mass became thicker, and yielded a membranous net-work, which is solid, white, translucent, insipid and inodorous, and easily reduced to powder. That muriatic acid is the best solvent of it, and when water is added, it becomes of an opaque white, and deposits a powder of a very high degree of tenacity.—See *Ann. de Chim.* vol. xl. p. 323–325.

7. *Decomposition of the Carburet of Sulphur by small electric forces.*—M. Becquerel has succeeded in this experiment. He places in a tube some carburet of sulphur, and above it a solution of nitrate of copper, which has a less specific gravity. A plate of copper is then plunged in both liquids. This assemblage forms a pile. The carburet of sulphur is decomposed, and also a part of the nitrate. There is formed a great quantity of crystals of the protoxide of copper on the plate of copper, and a deposition of carbon on the sides of the tube in very thin plates having a metallic aspect.—*Ann. de Chim.* Tom. xlii. p. 76.

III. NATURAL HISTORY.

ZOOLOGY.

8. *Notice of the appearance of Fish and Lizards in extraordinary circumstances.* By Joseph E. Muse.—In the course of the last summer, I ordered a ditch to be cut of large dimensions, on a line of my farm near Cambridge: the line was a plane, ten feet above the level of the neighbouring river, and at least one mile from it, at the nearest point of the line; a portion of the ditch being done, the work was interrupted by rain for ten or twelve days; when the work was resumed, on examining the performance, I discovered that the rain water which had filled the ditch, thus recently cut, contained hundreds of fish, consisting of two kinds of perch which are common in our waters, the "sun perch," and the "jack perch;" the usual size of the former is from six to twelve inches, the latter varies from ten to fifteen inches long; those in the ditch were from four to seven inches. By what possible means could these fish have been transported so far from their native waters? There is no water communication on the surface to conduct them there; the elevation and extent of the plane

in regard to the rivers, utterly prohibit the idea; the eggs, if placed there by a water-spout, could not have suffered so rapid a transmigration; no such phenomena had been observed, and the adjacency of the line to the dwelling, would have rendered the occurrence impossible without notice.

A similar occurrence a few years ago, I witnessed on the same farm; in a very large ditch, cut on lower lands, on a line equally unconnected with any river, pond, or other surface-water, there were, under very similar circumstances, numerous perch, which afforded fine angling to my children. In a diary which I keep, I have entered, that several of them measured as much as twelve inches in length, and that the time since their arrival there, could not possibly have exceeded a fortnight.

While on the subject of mysterious nature, I will introduce, as concisely as possible, a case, where she reconciled animals of the coldest and most meagre habits, to the enjoyment of the warmth and luxuries of the human stomach; for these facts, though not personally conversant with them, I have the authority of a medical gentleman of unquestionable veracity, to vouch for their rigid truth. In reply to my request to be informed of the habits, food, drink, enjoyment, &c. of the patient, I received the following account. "On my arrival I found that she (the patient) had puked up two ground puppies, and was labouring under a violent sick stomach, with pain, and syncope: the first was dead when ejected, the second was alive when I arrived, and ran about the room; they were about three inches long. She informed me, that on the road that morning she had thrown up two others. The case occurred in the summer, and had made gradual progress, from the first of April, and as she described it, with a peculiar sickness, and frequent sensation of something moving in her stomach; with slight pain and loss of appetite, which increased till her illness. She was about twenty years of age, and had enjoyed good health. Her employment had confined her in the swamp, during the winter and spring, and she had from necessity, constantly drunk swamp water." The physician administered an emetic in quest of more puppies, but, being disappointed, he gave an opiate; she was relieved, finally, and has been since in health.

These animals have since been shown to me: they are not the ground puppy, (gecko,) as they are vulgarly called. They resemble it very much, but are easily distinguished from it. They belong to the same genus, (lacerta or lizard,) but are of the species "salamander;" their habitudes too, are essentially different. The gecko is found in houses and warm places; the salamander in cold damp places, and shaded swamps, and by the streams of meadows; these animals, though oviparous, hatch their eggs in the belly like the viper, and produce about fifty young at a birth. The inference is irresistible, that the patient had, in her frequent draughts of swamp water, swallowed, perhaps thousands of these animals in their nascent, or most diminutive state of existence, and a few only survived the shock; but it is matter of astonishment, that from the icy element in which they had commenced their being, and for which they were constituted by nature, they should bear this sudden transportation to a situation so opposite in its character, and grow into vigorous maturity, unannoyed by the active chemical and mechanical powers to whose operation they were subjected.—*Silliman's Journal*, vol. xvi. No. 1. p. 41.

Art. XXIII.—CELESTIAL PHENOMENA,

From January 1st, to April 1st, 1830. Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellites, which are given in Mean Time.

N. B.—The day begins at noon, and the conjunctions of the Moon and Stars are given in Right Ascension.

JANUARY.

D.	H.	M.	S.	
1	14	34		☽ First Quarter.
4	1			☿ ☌ κ ♒
5	9	30	3	☽ ☌ 1 ♑ ♉ ☽ 51′ S.
5	9	59	31	☽ ☌ 2 ♑ ♉ ☽ 43′ S.
*5	14	59	34	☽ ☌ α ♉ ☽ 35′ N.
8	5			☿ ☌ λ ♒
8	15	32		◯ Full Moon.
12	12			☿ ☌ 1 2 β ♏
13	6			☽ ☌ ♓
*13	11	41	42	☽ ☌ ♌ ☽ 25′ N.
14	1			♀ ☌ λ ♋
14	22			☿ ☌ ν ♏
*15	17	53	21	☽ ☌ θ ♍ ☽ 26′ N.
16	16	3		☾ Last Quarter.
16	17			☿ ☌ θ ♑
18	19	54	20	☽ ☌ γ ♒ ☽ 8′ N.
19	23	41		☉ enters ♋
24	4	54		● New Moon.
26	7			♓ ☌ ☉
27				☿ Greatest Elong.
30	22	47		☽ First Quarter.

FEBRUARY.

* 1	13	43	35	☽ ☌ γ ♉ ☽ 47′ N.
2				☿ Stationary.
3	12	45		♄ ☍ ☉
7	7	42		◯ Full Moon.
7	8	40	26	☽ ☌ ξ ♌ ☽ 33′ N.
10	0			☿ ☌ B. Oph.
10	7	16	31	☽ ☌ β ♍ ☽ 13′ S.
11	11	30		☿ Inf. ☌ ☉
13	10	28	20	☽ ☌ κ ♍ ☽ 40′ N.
14				☿ Stationary.
15	12	28		☾ Last Quarter.
16	6	47	22	☽ ☌ φ Oph. ☽ 6′ S.
17	18	1	59	Im. III. Sat. ♃
18	14	21		☉ enters ♓
19	13	33		♃ ☌ 1 ν ♐ ♃ 3′ N.
20	10	43	40	☽ ☌ 2 β ♈ ☽ 43′ S.
21	9			☽ ☌ ☿
22	16	36		☉ Eclipsed Invis.
22	16	36		● New Moon.
24				♀ Stationary.
28	19	24	7	☽ ☌ γ ♉ ☽ 40′ N.

MARCH.

1	8	21		☽ First Quarter.
4	17	43	39	Im. I. Sat. ♃
6	6			♃ ☌ ● ♐
7	3	45		♀ Inf. ☌ ☉
9	1	31		◯ Full Moon. Morn. eclipsed invisible.
10				♀ Greatest Elong.
*11	8	21	36	☽ ☌ θ ♍ ☽ 39′ N.
12	6			☿ ☌ ν ♐
*12	17	24	25	☽ ☌ κ ♍ ☽ 43′ N.
14				♃ ☌ π ♐
*14	11	20	23	☽ ☌ γ ♒ ☽ 21′ N.
16				☿ ☌ ο ♐
17	5	36		☾ Last Quarter.
19				☿ ☌ ♃
20	14	32		☉ enters ♈
24	2	24		● New Moon. Sun eclipsed invisible.
25	16	55	4	Em. III. Sat. ♃
27				♀ Stationary.
27	2			♀ ☌ φ ♋
*28	3	14	51	☽ ☌ γ ♉ ☽ 41′ N.
28	4	28	48	☽ ☌ 1 ♑ ♉ ☽ 67′ S.
28	4	57	24	☽ ☌ 2 ♑ ♉ ☽ 59′ S.
*28	9	49	21	☽ ☌ α ♉ ☽ 19′ N.
30	18	58		☽ First Quarter.

Times of the Planets passing the Meridian.

JANUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	h	′	h.	′	h	′	h	′	h	′	h	′
1	0	20	3	15	20	36	23	9	14	31	1	43
7	0	37	3	9	20	26	22	48	14	3	1	20
13	0	53	3	2	20	17	22	28	13	36	0	59
19	1	6	2	52	20	8	22	8	13	8	0	29
25	1	13	2	41	19	59	21	49	12	41	0	5

FEBRUARY.

D.	h	′	h	′	h	′	h	′	h	′	h	′
1	1	3	2	24	19	50	21	27	12	10	23	39
7	0	31	2	6	19	43	21	8	11	44	23	4
13	23	34	1	44	19	37	20	49	11	19	22	49
19	22	53	1	18	19	31	20	31	10	54	22	29
25	22	28	0	6	19	26	20	13	10	29	22	5

MARCH.

1	22	20	0	23	19	23	20	8	10	13	21	53
7	2_{2}	17	23	41	19	18	19	43	9	49	21	33
13	2^{2}	20	23	7	19	13	19	25	9	26	21	11
19	2^{2}	28	22	37	19	9	19	6	9	3	20	50
25	22	39	22	13	19	4	18	48	8	40	20	29

Declination of the Planets

JANUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	°	′	°	′	°	′	°	′	°	′	°	′
1	24	37 S.	13	9 S.	18	5 S.	23	15 S.	16	38 N.	19	37 S.
7	23	14	10	34	19	6	23	15	16	46	19	31
13	20	54	7	56	20	1	23	14	16	54	19	27
19	17	43	5	20	20	51	23	13	17	3	19	22
25	14	3	2	49	21	35	23	11	17	12	19	16

FEBRUARY.

1	10	26 S.	0	8 S.	22	18 S.	23	8 S.	17	23 N.	19	10 S.
7	9	30	1	49 N.	22	48	23	4	17	32	19	4
13	10	58	3	20	23	11	23	1	17	41	19	0
19	13	16	4	15	23	28	22	56	17	49	18	55
25	14	55	4	24	23	37	22	52	17	57	18	49

MARCH.

1	15	25 S.	4	6 N.	23	40 S.	22	48 S.	18	2 N.	18	47 S.
7	15	19	2	52	23	38	22	44	18	9	18	41
13	14	14	1	11 N.	23	29	22	39	18	15	18	37
19	12	18	0	38 S.	23	13	22	39	18	19	18	34
25	9	32	2	13	22	51	22	30	18	23	18	28

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a celestial globe, and to determine their times of rising and setting.

ART. XXIV.—*Summary of Meteorological Observations made at Kendal in September, October, and November* 1829. By Mr SAMUEL MARSHALL. Communicated by the Author.

State of the Barometer, Thermometer, &c. in Kendal for September 1829.

	Barometer.	Inches.
Maximum on the 30th,	- - -	30.04
Minimum on the 14th,	- - -	29.06
Mean height,	- - -	29.55
	Thermometer.	
Maximum on the 2d,	- - -	67.5°
Minimum on the 20th,	- - -	35°
Mean height,	- - -	50.30°

Quantity of rain, 5.243 inches.
Number of rainy days, 22.
Prevalent wind, west.

The barometer has generally been much depressed during this month, and the mean is seldom so much below the average. The weather has been uncertain and subject to sudden changes from the prevalence of showers which have often occurred very unexpectedly. Though the thermometer has not yet been so low as the freezing point in the valley, the higher grounds have frequently been covered with hoar frost in the mornings. The quantity of rain for the year is still below the average. Though the most prevalent wind has been the west, we have had frequent winds from the north, which has made the air cool.

October.

Barometer.	Inches.
Maximum on the 27th,	30.20
Minimum on the 5th,	29.28
Mean height,	29.78
Thermometer.	
Maximum on the 3d and 5th,	57°
Minimum on the 23d,	30.5°
Mean height,	45.05°

Quantity of rain, 6.684 inches.
Number of rainy days, 19.
Prevalent wind, west.

About the middle of the month, or from the 9th to the 23d, we had very heavy rains. On the 14th, 2.533 inches were measured, which fell within the preceding twenty-four hours, the greatest quantity taken at once within the last seven years. The highest flood known for the last quarter of a century succeeded the heavy rain on this day. The thermometer has been but three times below the freezing point during the month, and the barometer has been mostly high. On the 7th snow was observed on the neighbouring hills for the first time this season. At half past ten o'clock on the evening of the 25th, the Aurora Borealis was observed in five distinct streaks of light parallel to each other, the lowest about 30° above the horizon, and crossing the magnetic meridian at right angles.

November

Barometer.	Inches.
Maximum on the 17th,	30.23
Minimum on the 4th,	29.44
Mean height,	29.80
Thermometer.	
Maximum on the 13th,	52°
Minimum on the 19th,	26
Mean height,	39.20

Quantity of rain, 3.855 inches.
Number of rainy days, 15.
Prevalent wind, west.

From the beginning of the month to the 15th the weather was wet and unsettled. Since that time, though very little rain has fallen, it has been dull, cloudy, and more frosty. There has been more uniformity in the meteorological appearances of this month than is generally the case at this season of the year.

ART. XXV.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

THE Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about ¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the instruments is 300 feet above high water-mark at Leith. The morning and evening observations were made about 10 A.M. and 10 P.M.

SEPTEMBER 1829.

D. of Week.	Day of Month.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	64	51	57.5	55	65	60	29.88	29.79	
W.	2	46	44	45	46	62	54	29.75	29.92	
T.	3	55	48	51.5	37	59	48	29.88	29.71	
F.	4	57	52	54.5	47	60	53.5	29.60	29 49	
S.	5	55	51	53	48	59	53.5	29.18	28.92	.33
S.	6	60	51	55.5	48	62	55	28.97	29.06	
M.	7	57	49	53	45	61	52	29.18	29.28	.33
T.	8	50	50	50	47	54	50.5	29.08	29.16	.05
W.	9	57	49	53	45	61	53	29.19	29.32	
T.	10	54	48	51	40	55	47.5	29,30	29.23	.12
F.	11	55	48	51.5	45	59	52	29,23	29.23	
S.	12	55	48	51.5	46	58	52	29,12	29.13	
S.	13	54	56	55	45	59	52	29,10	29,06	.01
M	14	55	44	48.5	44	57	50.5	29.01	29,20	
T.	15	54	47	50.5	39	58	48.5	29.29	29.50	
W.	16	55	42	47.5	35	55	45	29.52	29.51	.18
T.	17	51	46	48.5	37	56	46.5	29.51	29.35	
F.	18	51	48	49.5	42	51	46.5	29.25	29.36	.08
S.	19	51	46	48.5	45	54	49.5	29.59	29.74	
S.	20	50	51	50.5	36	55	45.5	29.50	29.20	.09
M.	21	54	47	50.5	47	57	52	29.28	29.28	
T.	22	55	48	51.5	45	57	51	29.32	29.38	
W.	23	55	44	49.5	45	59	51	29.50	29,65	
T.	24	53	45	49	36	55	45.5	29.74	29.91	
F.	25	50	51	50.5	35	57	46	29.90	29.84	
S.	26	56	57	56.5	45	63	54	29.55	29.43	
S.	27	51	46	48.5	47	62	54.5	29.35	29.35	.08
M.	28	52	43	47.5	40	56	48	29,65	29.77	
T.	29	50	46	48	38	55	45.5	29.84	29.95	
W.	30	52	48	50	36	57	46.5	30.00	30,07	
	Sum,	1610	1444	1527	1282	1736	1509	883.24	885.79	1.77
	Mean,	53.67	48.13	50.9	42.73	57.87	50.3	29.441	29.459	

OCTOBER 1829.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
T.	1	55	45	49	45	58	51,5	30·15	30.08	
F.	2	52	50	51	37	57	47	30.05	29.52	
S.	3	55	46	50.5	45	58	51.5	29.32	29.46	.06
S.	4	56	51	53.5	43	60	51.5	29.48	29.18	
M.	5	52	43	47.5	44	55	49.5	29.02	29.24	.10
T.	6	45	37	41	35	52	43.5	29.38	29.38	
W.	7	43	35	39	32	48	40	29.34	29.59	
T.	8	43	35	39	30	46	38	29.81	29.97	
F.	9	43	48	45,5	30	48	39	29.99	29.99	
S.	10	56	53	54.5	46	57	51.5	29.98	29.89	.05
S.	11	59	51	55	41	61	51	29.70	29.62	
M.	12	48	46	47	38	53	45.5	29.84	29.68	.70
T.	13	47	42	44.5	41	49	45	29.42	29.32	
W.	14	45	37	41	38	47	42.5	29.60	29.92	1.05
T.	15	43	40	41.5	29	48	38.5	30.03	29.76	
F.	16	56	47	51.5	41	58	49.5	29.26	29.44	.04
S.	17	48	48	48	42	52	47	29,80	29.67	
S.	18	56	53	54.5	45	59	52	29.62	29.63	.03
M.	19	58	56	57	48	60	54	29.60	29,40	
T.	20	54	46	50	46	57	51.5	29.34	29.55	.07
W.	21	46	47	46.5	38	50	44	29.23	29.31	.17
T.	22	48	36	42	42	51	46.5	29.56	29.73	
F.	23	42	39	40.5	30	46	38	29.78	29.78	
S.	24	46	47	46.5	40	50	45	29,68	29,58	.07
S.	25	48	46	47	39	52	45.5	29.90	30.06	
M.	26	48	48	48	39	53	46	30·15	30.12	
T.	27	51	44	47.5	46	55	50.5	30.10	30.08	.10
W.	28	45	35	38	35	46	39.5	30.25	30.23	
T.	29	44	49	46.5	30	49	39.5	30.08	29,80	.08
F.	30	54	45	49.5	45	56	50.5	29,65	29,65	.03
S.	31	42	37	39,5	34	45	39.5	29.88	29.95	
		1526	1378	1452	1212	1636	1424	920.97	920.56	2.53
		49.22	44.45	46.84	39.13	52.77	45.9	29.709	29.695	

NOVEMBER 1829.

D. of Week.	D. of Mon.	Thermometer.			Register Therm.			Barometer.		Rain.
		Morn.	Even.	Mean.	Min.	Max.	Mean.	Morn.	Even.	
S.	1	38	43	40.5	30	45	37.5	29.95	29.97	
M.	2	47	43	45	40	40	40	29.93	29.83	
T.	3	51	51	51	42	55	48.5	29.72	29.42	
W.	4	51	42	46.5	42	53	47.5	29,20	29.32	.11
T.	5	45	46	45.5	39	50	44.5	29.53	29.45	.13
F.	6	46	37	41.5	43	49	46	29.26	29.37	
S.	7	42	37	39.5	34	45	38.5	29.45	29.62	
S.	8	37	34	35.5	31	45	37	29.69	29.63	
M.	9	35	37	36	27	42	34.5	29.80	29.68	
T.	10	47	45	45	31	50	40.5	29.58	29.52	
W.	11	47	49	48	38	49	43.5	29.66	29.48	.31
T.	12	49	45	47	46	50	48	29.46	29.73	.60
F.	13	43	38	40,5	39	47	43	29.97	29.95	.55
S.	14	40	41	40.5	35	41	38	29.89	29.67	.31
S.	15	43	36	39.5	35	47	41	29.74	29.93	
M.	16	39	36	37.5	31	45	38	30.11	30.22	
T.	17	31	28	29.5	27	41	34	30.22	30.19	
W.	18	31	32	31.5	25	37	30	30.19	30.13	
T.	19	38	39	38.5	27	41	34	30.13	30.03	
F.	20	42	41	41.5	31	45	38	30.00	29.92	
S.	21	42	42	42	39	46	42.5	29.84	29.67	.16
S.	22	38	40	39	36	42	39	29.57	29.72	.14
M.	23	42	42	42	38	44	41	29.77	29.78	
T.	24	39	38	38.5	33	40	36.5	29.90	29.94	
W.	25	38	37	37.5	33	38	36.5	29.91	29.88	.17
T.	26	37	38	37.5	33	41	37	29.90	29.73	
F.	27	39	38	38.5	35	40	37.5	29.63	29.54	
S.	28	39	38	38,5	32	42	37	29,56	29.58	
S.	29	41	42	41.5	36	42	39	29.54	29,50	
M.	30	38	37	37.5	33	43	38	29.58	29.64	
		1235	1190	1212.5	1041	1331	1186	892.48	892.04	2.48
		41.17	39.67	40.42	34.7	44.37	39.53	29.749	29.733	

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ART. I.—*A Visit to Berzelius.* By JAMES F. W. JOHNSTON, A. M. Communicated by the Author.

AMONG the *elder* chemists of this age, who, taking up the science of chemistry in its youth, have presided over and guided its advance to manhood, Davy, Wollaston, and Thomson in our own country, Gay-Lussac in France, and Berzelius in Sweden, have deservedly attained the first rank. Many others have trodden hard upon their steps, even in experimental research;—while Dalton, standing almost aloof from experiment, has at once, by the mere force of thought, conceived and digested a theory of chemical combination, which manipulation, by its patient investigations, is every day confirming,—securing to himself, thus, in the history of the science, a place, perhaps higher, certainly apart from that of his more laborious contemporaries;—yet still in our time most chemists look up to one or other of those men as the most ardent and successful promoters of their favourite pursuit.

Davy's career was a bright and dazzling one; pity his sun should have set in comparative obscurity! Wollaston died as he lived, bearing to his grave the honours and rewards of indefatigable devotion to science. Of those who yet remain to us, Gay-Lussac has run undoubtedly a brilliant course; but his star has been periodical, and has burned occasionally with a flickering and unsteady light. He is a learned and skilful

and accurate chemist; but his whole life is not in his science. He is a man of the world as well as a philosopher. He can leave his laboratory to partake in the trifling pursuits of other men, and thus it is but at times that he labours. Yet is high and deserved respect due to him; and what Byron said of Campbell, may with equal justice be said of him,—"*he is one of those few men who have written too little.*"

There remain but two individuals of those I have mentioned,—unlike in many things, yet deserving to be named together as persons to whom chemistry is as their "meat and drink," and as the founders of two schools of pains-taking and laborious men. Of one of these, Thomson, I had seen and known much; and the high respect with which he always spoke of Berzelius, was not the least of the many circumstances which strengthened the desire I had long entertained of seeing the father of analytical chemistry. I am induced to publish this account of my visit to him, under the persuasion, that any thing, however imperfect, concerning so highly esteemed a chemist, cannot fail to be interesting to scientific men.

I reached Stockholm on the 6th September, and on the following morning walked down to the Academy buildings in the *Stora ny Gatan*, to wait upon Berzelius. I found him in his study, busy writing for the new edition of his chemistry. On announcing my name, he did not wait for my letters of introduction, but at once gave me a kind and hearty welcome. I had not formed any very definite idea of his appearance, yet I was a little taken by surprise when I first saw him; and I fear I was almost guilty of rudeness, by the fixed and earnest manner with which I contemplated his features during the whole of my first visit. Berzelius has not perhaps a handsome face, but his features are delicate, and their expression entirely pleasing. That of his mouth is very peculiar, and indicative, in a high degree, of good humour and good nature. There is a portrait of him engraved at Berlin, in which this expression is remarkably well preserved. Busts in porcelain, and medallions in cast iron, are also made at Berlin, in which the likeness is sufficiently striking.

Berzelius is now about fifty years of age, of the middle

height, and slightly inclined to corpulency. In a man of great name, one, foolishly perhaps, yet naturally, looks for something correspondent in external appearance. Berzelius has none of this,—nothing either natural or assumed to distinguish him from other every-day men. He has nothing of pretence, reserve, or singularity about him, so that his plainness drew from a fellow-traveller of mine whom he allowed me to introduce to him, the observation, " I would never have thought him the great man he is said to be." He has nothing even of the hard student in his appearance; and, on a first introduction, one would scarcely suppose he was the same Berzelius of whose " sayings and doings" he had heard so much. He is of an exceedingly pleasing disposition, and gentlemanly manners; and, on a longer acquaintance, one cheerfully falls in with the general opinion, that if he differ at all from other men, it is in being more amiable. His attention to strangers, and particularly to foreigners, is always great; and, from his kindness to myself, I might perhaps have been suspected of expressing myself too strongly as to his amiable manners, had I not been confirmed in my opinion of him by that of many others, as well Swedes as foreigners, whom I met in the course of my tour. " You *will* find him," said they to me before I reached Stockholm, and after I left it, " *Did* you not find him, an exceedingly attentive and amiable man."

The Academy of Sciences, of which Berzelius is perpetual secretary, and in the buildings belonging to which he has his residence and private laboratory, has lately purchased a larger and more commodious house, and all things were in the act of removal at the time of my visit. I came therefore at an inconvenient time both for seeing Berzelius, and for profiting by access to his laboratory. His former laboratory was dismantled, and his new one still in a state of imperfection, so that what he could then find time to do was chiefly in the way of writing. Still he with great kindness set about getting his laboratory in order, proposed that we should make a set of experiments together,—a highly flattering way of giving me the opportunity for which I had come to Stockholm of seeing his mode of operating, and, if possible, of picking up something that might hereafter be useful to myself. In the course of

these experiments he was open with every thing, anxious to explain every minute circumstance necessary to the attainment of precise results, and in the most familiar way to make me acquainted with all the little contrivances experience had shown him to be useful in the prosecution of analytical investigations. "Come," he would say, "while this process is going on, I will show you two or three little things that you may find it convenient to know." And it was the same every day; so that, independent of the instruction I gained, the time also passed most pleasantly. And then, when we were not engaged in the laboratory, he would show me his minerals or his preparations, of both of which he possesses many rarities,—or point out to me the results of foreign chemists on some subject we had been talking of,—or assist me in translating the passage if I found it obscure,—or himself translate whole pages to me from an author I could not understand.

Berzelius used formerly to have private working-pupils, a practice he has now discontinued. Their number, however, was always small; so that in the whole of Sweden there are only eight or nine who have enjoyed that advantage, and in Germany there may be as many more. He is always willing, however, to receive visitors into his laboratory, and to teach them those resources which his long experience has made known to him.

It is interesting to learn the first steps of an eminent man in his own favourite track. Berzelius had gone to Upsala to study medicine as a profession, and among other branches, of course applied himself to chemistry. Afzelius, who is still a professor in Upsala, and his adjunct, Ekeberg, had charge of the chemical prelections and experiments. It was then the custom, as I believe it still is at Upsala, Stockholm, Lund, and Copenhagen, that, besides the public lectures, the students were permitted to attend the laboratory and operate, under certain restrictions. At that period each student could demand an operation once a week. Berzelius, like the rest, went to the laboratory soon after he had commenced his chemical course, and asked for an operation. The first that was given him was to form colcothar of vitriol, (crocus martis,) by heating sulphate of iron in a crucible. "Well," says he, "every

servant can do this. If this be all I am to learn, I may as well stay away."—" Oh but," replied Afzelius, " your next operations will be more difficult." Accordingly, when he asked for a second operation, he was instructed to prepare caustic potash, by burning cream of tartar in a crucible. " This so disgusted me," says Berzelius, " that I vowed I would never ask for another operation. Still I frequented the laboratory, and at the end of three weeks found myself attending regularly every day, though I had no right to do so, and Afzelius could have turned me out. Yet I was allowed to return and operate, and break much glass, while Ekeberg, especially, was exceedingly annoyed that I never asked a single question ; for," he adds, " I liked better to seek for information from reading and thinking and experimenting, than from men, who, having little practical experience themselves, gave me, if not evasive, at least unsatisfactory answers regarding phenomena they had never themselves observed." Chemistry at that time was at so low an ebb, that nobody thought of studying it for its own sake. Yet in this way, led on by an increasing interest in the pursuit, did Berzelius, while at Upsala, lay the foundation of that high name in the chemical world to which he has since attained. This short account, which I had from himself, throws much light on the sources of his distinction. In that ardour and perseverance which led him on, fighting single handed with all his difficulties, we see a sure foundation of future eminence—in his continued experimenting the origin of that extensive knowledge of facts and phenomena for which he is now so remarkable,—and in his being driven thus early to his own resources, the commencement of those habits of close-thinking which pervade all his chemical writings.

After leaving the university, he was appointed assistant to Sparrman, the same who had sailed with Captain Cook, and who was at that time professor in the School of Medicine at Stockholm. On the death of Sparrman in 1806, he succeeded to his chair. At this time there were only three porfessors in the School of Medicine, so that the load devolving upon each was very great The profession of Berzelius in-

cluded medicine, botany, and chemical pharmacy. * At a later period, four more professorships were instituted, and that of chemical pharmacy became the branch of Berzelius. As matters formerly stood, though entitled professor of botany, he never gave lectures on that science, at least in Stockholm. To the cadets of the Military College of Carlberg, near Stockholm, he formerly gave lessons on this subject. On medicine alone he lectured for two years, after which time he commenced also a chemical course. His medical prelections were always well attended—his chemical in former times very indifferently, and for a very sufficient reason. It was the custom in Stockholm, as it still is at Upsala, to give dry lectures on chemistry without experiments, than which scarcely any thing can be more tiresome and uninteresting. "I knew not how to set about them," says Berzelius: "and it was not till 1812 when I was in London, that Dr Marcet took me several times to his lectures, and gave me besides a copy of the list of experiments for his course by which to regulate my own. This list I improved and augmented so much, that when I afterwards met Dr Marcet at Geneva, he took a copy of mine, and since that time it has been copied and re-copied by different persons, perhaps fifty or sixty times, and each varies or augments it in something." The addition of experimental illustrations soon gave the chemical the superiority over the medical classes in public estimation, so that while in Stockholm the medical lectures are but thinly attended, those on chemistry obtain a well filled auditory. My visit to Berzelius was during the summer vacation, so that I had not the pleasure of hearing him lecture; but as he delivers them either extempore or merely from notes, I should think they must be very inte-

* How many branches are still taught by one person in some of the foreign universities may be seen by the following announcement in the "Catalogus Lectionum" of the university of Upsala, for the season commencing in October 1829. Adamus Afzelius, Med. Doctor. Phil. Magister, Materiæ Medicæ et Dieteticæ Professor Reg. et Extraord. Atque Facultatis Medicæ Adsessor, hoc Anno Praelectionibus publicis, in Auditorio Medico Hora IV habendis, Diaeteticam Semestri praeterito inchoatam praelegere perget; privatim vero, in suis Aedibus, Semestri autumnali Medicamenta simplicia monstrabit, et vernali Elementa tradet Materiæ Medicæ, cum Zoologica, tum Botanica.

resting. "You cannot expect to interest people in such things," he would say, "unless you personally address them; reading does not instruct them so effectually."

Berzelius has had a long and splendid chemical career, and his personal appearance seems to promise yet a long continuance of his valuable life. He is troubled at times by the gout, and by a disease resembling the tic douloureux, which affects him with violent pains in the head, but his ordinary state is that of good health. No man living has done so much for chemistry as he has done, and none can turn to better purpose whatever years may yet be spared to him. The loss which England sustained so lately of three of her most eminent scientific men in the short space of six months, makes us tremble for the lives of those who are still left to us abroad.

Though in good health, and apparently strong, Berzelius complains of the approach of age. For two or three years he has been unable to read well without spectacles, and he speaks of a change in his memory. "Formerly," says he, "one reading of a scientific paper made me master of its contents, now I must read it twice; and while formerly I knew what was in every glass around me though they stood for months unlabelled, now I must label each, or I immediately forget what it contains." If any man has a right to retire from active life it is Berzelius, but this fortunately for science he cannot do. His nature commands him to seek employment, and it will only be with his life that he can cease to be active.

Though, therefore, in consequence of what he considers as symptoms of the approach of old age, he retire this winter from the duties of professor in favour of his assistant, Dr Mosander, science, it is to be hoped, will only gain by the arrangement. His time will be more entirely at his own disposal, and his chemical investigations more undisturbed. He still retains the office of Secretary to the Academy of Sciences, and has apartments and a laboratory in the buildings which belong to it. For another year he remains titular professor, when he proposes to resign the title also to Mosander. "He is better qualified for the office than myself," says Berzelius with his usual candour, "for, besides his scientific education, he has also spent his youth in an apothecary's shop, and being, as

professor of pharmacy, the surveyor and controller of all the apothecaries in the kingdom, it is better he should know all their tricks."

Berzelius is a man of incessant application, being employed almost every day for twelve or fourteen hours. Yet for all he has done as an experimental chemist he does not work in his laboratory without intermission. Sometimes when engaged in writing he does not work in it for months. If in writing, as he has been much lately for the new edition of his chemistry, he meet with any subject which seems darker than usual, he quits his pen, betakes himself to his laboratory, and there, from six or seven in the morning to perhaps ten at night, he continues his investigations day after day till he has removed the obscurity as far as possible to his own satisfaction, when he returns again to his writing. This was the case with his late experiments on Indigo, which were undertaken solely for the new edition now publishing at Paris.

For this alternate writing and experimenting the arrangement of his apartments is admirably adapted. A suite of three rooms on one floor form his laboratory and study, while his dwelling-house is above. His study is his sitting-room, in it he receives his morning visitors, and, being unmarried, he has few calls to leave it; while his apparatus being all arranged at the distance of a few yards, he can at any time commence a series of experiments without the loss of a single moment. Thus he is enabled to husband his time, and by turning every hour to the best advantage to make them doubly valuable. His library, his writing-table, his re-agents, and his furnaces, all are collected into one convenient space, uniting together the records of old investigation and the means of new discovery.

Perhaps I shall not be thought tiresome if I attempt a short description of this interesting locality. The stranger in Stockholm bends his way along the *Drottning Gatan*, the most fashionable part of the city, till he comes to the *Kungsbacka*, and the cross street called *Kyrko Gatan*, at the head of which stands the church of Adolph Frederick. The corner house in this street is *Westmanska huset*, the large building lately purchased by the Academy. Entering from Drottning Gatan, he ascends

two short flights of stairs, when he finds a door facing him. If he knock he may receive no answer, or at most a simple "Kom in;" his safest way therefore will be to enter, and, lest he should be afraid of intruding, he will hear a little bell giving notice of his entrance. The room in which he now finds himself, he will immediately discover, by various significant implements which stare him in the face on every side, to be part and parcel of a chemical laboratory. I suppose him to be something of a chemist, an amateur at least, from his taking the pains to follow all these directions; but should he not, or should he be of delicate nerves, he need not run away at the sight of these chemical tools, in apprehension of the various sweet smells which often render laboratories so attractive to strangers. They are here all carefully got rid of by ventilation, and even though he see processes going on, he may yet proceed boldly forward. On his right hand, while still near the door, he will see, carefully adjusted by the window, a mercurial trough of stone, with 100 pounds of mercury dazzling in the sun. On his left, a trap staircase leading to the floor above, and near it some of the viler apparatus, such as contain water and other slops. Going forward, let him deviate a little to the left to avoid coming in contact with a table which stands between the windows, and projects to a considerable distance into the room. If he stop a moment at the end of this table, and cast his eye to the right, he will see near the second window a small porcelain table with raised edges, and probably some glasses standing upon it, denoting that some experiment is, or has been lately going on, while against the wall on one side of the window, he will observe a small oil lamp by Knight, of Foster Lane, burning probably with the *Sprutflaska* suspended over it, and on a shelf on the other side various little contrivances for facilitating the disposition of apparatus for the purpose of experiment. Bringing back his eye over the blowpipe, its huge lamp and its fragments of glass, he may glance in passing at the sand-bath and heating arrangements. He will see here no built up or brick furnaces; these are well enough for essaying or for carrying on chemical investigations by wholesale, as is somewhat the fashion now a days, but they are too vulgar implements for the pur-

poses of really refined analysis. On a brick hearth raised three feet from the floor, and covered at the height of three or four more for the purpose of carrying off the fumes, stands a small sand bath heated by a charcoal fire, and a little iron furnace with perforations for tubes, muffles, &c. These are all he will see in the shape of furnaces; but if an experiment be in process, he will probably notice upon this hearth a neat arrangement of bottles and tubes, stimulated to action in their inward parts by the heat of a large spirit lamp, such as the coffee-drinkers of Paris use for boiling their morning beverage.

But before this time he has been looking to the left, where the view opens through a doorless doorway into the second chamber, and his eyes have rested on a glass-case standing upon the table right before him. He may walk forward and examine it. It is *the balance.* How much light has that little machine scattered over every department of nature! how many phenomena has it explained! how many hidden truths has it made known! how many disputes too has it settled,—how many hypotheses overthrown,—how much ingenuity scattered to the winds. Who in former times could have imagined that the determination of abstract truth and the developement of the laws of nature would ever come to be referred to the oscillations of those two unstable arms? But regard *that* balance with earnest attention, for it has wrought mighty service in the cause of science. That mode of raising up and resting the arms and scales, is a contrivance of the late Assessor Gahn, whose ingenuity in these matters has been so justly praised. The merit of first making the scales loose, and resting them on knife edges,—an invention which Berzelius praises much, without knowing to whom to attribute it, is due to the celebrated Mr Cavendish. His balance, which came into the possession of Sir Humphrey Davy, and by him was given to Mr Children, is fitted up in this way; yet no one thought it of any consequence till Mr Robertson of Devonshire Street, Portland Place, saw the merit of it, and by adopting it, has brought his balances to that high degree of perfection for which they are so highly esteemed by those who are fortunate enough to possess them. Mark one other thing in that balance which lessens

the labour of weighing much; each arm is divided into ten equal parts. It is the principle of the steelyard first applied to the common balance by Gahn, so that, when you come near the equipoise, you can balance completely, and estimate your weight to the most minute fraction, without changing your weight, simply by moving your last millegramme backwards or forwards on the arm. Those leaden weights in the drawer are likewise intended to abridge labour. They are exact counterpoises for all his crucibles and other small platinum vessels, so that any of them may be balanced almost immediately. Open also those little boxes, and in the more or less minute portions of gum lac attached to the weights, you will see evidence of that nice adjustment without which the indications of the most perfect balance were useless. Round this room are arranged sets of drawers and glass-cases, containing apparatus, tests and chemical preparations, all set aside and arranged with the greatest order and neatness. That other table beside the window is fitted up for researches with the mouth blowpipe, on which Berzelius has written so able a work.

Turn now to the left, and through another doorway behold him whom you have sought in vain in the two other apartments. That is Berzelius. He is busy writing; his table covered with journals, and his shelves groaning with books. You see that little cabinet on his left. In the drawers of that little cabinet are contained all his rarest chemical substances and compounds, his Rhodium, Osmium, Selenium and their preparations; his Fluorides, his Salts of Lithia, Yttria, Thorina, with many other choice combinations to be met with no where else, all of which he will not fail to show you—of some you may even hope to become possessor. Now you may walk forward and introduce yourself, secure of a welcome reception.

Every thing in Berzelius's laboratory speaks of neatness, cleanliness and order. No bottles or dirty vessels scattered about; every thing is put away in its place ready to be laid hold of when wanted. His arrangements for experiment are of the simplest and neatest kind, and he has many little machines for facilitating these arrangements, the merit of all

of which he gives at once to the late Assessor Gahn. The execution at least is his own, for his own turning-lathe, and his own tools, make all his contrivances in wood. Through his whole laboratory indeed, may be seen marks of that same scrupulous nicety which have made his analytical determinations so valuable. In Sweden they have the benefit of glass free from lead, and of a filtering paper made expressly for the purpose, and unequalled in the world. It is made in winter, and being hung up to dry in a frosty atmosphere, the water freezes and makes it porous, so that while it is sufficiently close to retain all undissolved matter, liquids pass through with great rapidity. Its excellence, and the recommendation of the Swedish chemists, have brought it into great request, and much of it is in consequence exported. It contains no soluble matter, and leaves only 1-6000 of its weight of ashes. The usual mode employed by Berzelius is to weigh his filter, and after collecting his precipitate to burn it, allowing 1-6000 for the weight of the ashes. A slight error here in the weight of the filter it will be seen cannot affect the result. He condemns the mode of double filters unqualifiedly. It was formerly his own way of operating, and he cannot bear that others should follow a method he has long given up for its inaccuracy. Decantation he never employs, but collects always his precipitates on the filter. For washing them he uses commonly the *Sprut flaska* (squirt flask) with warm water. This is infinitely better than the flask with cold water, inasmuch as it keeps up a constant stream without the trouble of blowing into it, and at the same time, serves all the purposes of the syringe recommended by Faraday. If the aperture be small enough, there is not the slightest risk of loss from little drops or sparkles flying off. While on the subject of manipulation, I may mention a method of pouring which I learned also from Berzelius, and which has many advantages over the rod. It is simply to touch the edge of the glass at the spot to be poured from with a little grease. The end of a candle does very well, or a bit of tallow made into that shape, and covered with a small case to prevent its soiling the fingers. By the use of this precaution liquids may be poured with ease even from a wide mouthed vessel without the loss of a drop.

Of Berzelius as a chemical philosopher, there is but one opinion. He unites the three great requisites, patient industry, clear thinking, and dextrous manipulation; and the scientific journals of the last twenty years, contain ample proofs of the able manner in which they have been exercised. In regard to some of his peculiar views, there is a difference of opinion among chemists, but almost all that makes them peculiar may be traced to his excessive caution,—a fault which, in a science depending upon experiment, though it sometimes retards the acknowledgment of a true theory, will rarely lead to error. When he began his labours at Upsala, the whole science was a mass of crude theories soldered together, whenever a flaw appeared, by some new fancy more ingenious than the rest. These he found to be the greatest obstacles in his way, and hence probably it is that he has all his life long set himself against the spirit of theorizing, which, usurping the place of true philosophy, had built hypotheses upon hypotheses, and called the result a science. Even now he perhaps undervalues something too much a merely theoretical paper; but this propensity is attended by one advantage, that when Berzelius adopts such a notion, it is certain there are very good grounds for it indeed.

In the North of Europe he is better known than in Britain, his name standing above that of every other chemist, and his authority on all subjects connected with chemistry having little less than the force of a law. How high he ranks in Germany, in particular, may be inferred from the fact that, in a late *History of the Devil*, of which so many are published in that country, one of the main inducements his Satanic majesty is represented as holding out to a convert still half-doubtful of selling himself, is, that he will make him *a Berzelius*. The cause of this high respect is probably to be found in their wider acquaintance with his works, all his papers and works being published in German, either directly by himself or through the medium of others. It is a pity that the professedly chemical journals in this country should pay so little attention to those published in Germany. The editors of these journals are indefatigable; they permit nothing to escape them.

But besides his distinction abroad and among men of science

in general, he has the singular good fortune to be if possible still more highly esteemed at home. The honours which his labours have merited, his amiable manners have disposed every one to heap unanimously upon him, so that almost every educated Swede will tell you he is proud of him. On this subject men of all parties agree, unless a solitary exception to this otherwise universal opinion may be found in the members of the rival medical school at Upsala, who are said not to speak of him at all times in the very highest terms. Conversing one day of Berzelius with a distinguished opposition leader in the Swedish house of Peers, "I know him," he said, "and esteem him, and as a Swede am proud of him. He differs from me in politics, always voting for ministers when he comes to the house; but he treats all parties with great respect, and then he holds no pension,—so that with all his claims upon my regard, I know of nothing that should diminish the very high respect I entertain for him." On another occasion, speaking to a gentleman in Stockholm of the works and mines I thought of visiting in different parts of Sweden, he remarked of certain proprietors, that they were shy in admitting strangers, but added, "a word from Berzelius will open to you every door in Sweden." Though a member of the house of Peers and an elector, Berzelius takes little share in political affairs, and hence avoids all contact with party spirit, which prevails in Sweden as in other countries.

The King of Sweden has not been slow in bestowing suitable marks of distinction upon one whom the general voice had already pointed out as most worthy. He has conferred upon him the cross of the order of Vasa and the grand cross of the Polar star, besides the almost entire patronage of the chemical and medical chairs in Sweden, whenever he chooses to interfere or to recommend. This influence he exercises in the most liberal manner, for if there be any trait in his character for which he is more remarkable than another, it is his zeal in the cause of science. He will do much to secure to it a faithful and laborious cultivator. Of one individual to whom he had procured a chemical chair, but who for several years had done nothing, he said to me "He makes many excuses of his want of time, but I told him it was easy to see he did not need to

work ; those who need to work always find time." Another day speaking of a young English gentleman who had been introduced to him, and to whom he had promised letters, but who had gone without receiving them,—" I am sorry he should not have called, for I had so little opportunity of conversing with or paying him any attention when I formerly saw him ; he is young, rich, has plenty of time, and with his taste for science he might perhaps do something."

Thus honoured and esteemed, it may easily be supposed that Berzelius has many visitors and correspondents. Besides formal visitors, his friends and colleagues often drop familiarly in upon him ; but it is only in the case of particular individuals that he intermits his occupations, so that he enjoys society and advances his labours at one and the same time. His correspondence, which, partly no doubt from his situation as secretary to the academy, but chiefly from his celebrity, is very great, takes up much of his time. Thirty or forty letters in a week are no unusual quantity, but every thing goes on quickly with him. He composes and converses at the same time, and is little interrupted in writing his papers, his books, or his letters, by the presence and conversation of his many visitors. A gentleman who lately arranged his letters, told me he had upwards of 200 correspondents, and these not in his own department merely, but having among them such persons as Madame de Stael, Goethe, Prince Metternich, the ministers of Prussia, &c. &c. His influence in Berlin indeed is little less in his own department than in Stockholm, and almost all the young professors connected with chemistry in the several institutions in that capital, if they have not been directly recommended by him, have at least been pupils of Berzelius.

What Berzelius is in private life he has generally been also in his published writings ;—impartially judging, giving praise where due, and treating with courtesy even those from whom he differed. In two unhappy instances only has he broken through those rules of established courtesy recognized in almost all philosophical discussions. To Dobereiner and to Thomson he has forgotten all his wonted urbanity. His remarks upon Dr Thomson's last work* might well have been

* He might have thought at the time he wrote them of Dr Ure's cri-

spared, it being by no means usual in this country for chemists to declare each other unworthy of credit. There may be, and no doubt there are, several errors in a book professing to give the results of so great a number of analyses, but these ought rather to have been pointed out singly than sweepingly announced; and if common courtesy was not enough to secure this, the respect due to a chemist who has dedicated a whole life to the advancement of the science, ought to have been an ample title to due forbearance. Of Thomson's results, Berzelius says first, that the method employed for obtaining them may in some cases admit of very good approximations, but that it cannot at all be depended on for precise atomic weights; for, *second*, suppose we knew beforehand the precise atomic weights of two bodies, yet unavoidable errors in the weighing are sufficient to prevent exact mutual saturation; and *lastly*, that to have performed as they ought, all the analyses given, would have taken a lifetime. On these grounds, added to some errors he has found, he rejects the whole work, weights and all,—of course in favour of his own.

Berzelius himself allows of Dr Thomson, that he is an accurate observer of phenomena, that he is moreover the most learned chemist in England,—the most fearless in expressing his opinion, regardless of high names, and the most willing to do every man justice; and that, had he confined himself to the office of a redacteur, he would have earned a high and deserved reputation. Now, after all these honourable admissions, surely his writings are not to be repudiated on account of errors in manipulation, into which the theory he has adopted may at times have led him; much less ought they to be held up to scorn as so much quackery, and the veracity of their author called in question because his experimental results happen in some cases to be incorrect. Chemists on the continent, among whom Berzelius is every thing, are shy of speaking of Thomson. They do say "Il fait ses experiences un peu en

tique upon his own Mineralogy, published in the first volume of the *Quarterly Journal of Science*, and which called forth so severe a note from Dulong in the *Annales de Chimie*. "This critique," says Berzelius, "was so severe as to make me *laugh*." Did he expect that saying still severer things was to make Dr Thomson *sing*?

cavalier;" yet even they cannot tell why Berzelius should have treated him with such exceeding want of respect. At Copenhagen I was led to believe there was some personal feeling mixed up with this hostility; but on talking over the matter with Berzelius himself he assured me there was not the slightest foundation for such an opinion; and he moreover told me, —a thing which he did not authorize me to state, but which I am led to hope he may be glad to see thus pubicly expressed, that he would now willingly withdraw the offensive words he employed in regard to Thomson's book; and I may add, that he did not appear half pleased at their being raked up and republished in the *Philosophical Magazine* after the lapse of two years, and when every body else was trying to forget them.

Between Davy and Berzelius there was a personal dislike, arising first from some errors in the chemistry of the former, which Dr Young induced Berzelius when in London to write out for him confidentially, and which, on the return of Berzelius to Sweden, he communicated to Davy. These remarks offended Davy exceedingly, and his irritation was carried still farther by a letter of Berzelius which appeared soon after in a German journal. Irritation on the part of Berzelius was excited at a later period, when Davy was in Sweden. Hearing while at Gottenburg that Berzelius was in the south of Sweden he wrote him desiring he would not leave Helsinborg till a certain day, when he would meet him. Accordingly, Berzelius, with Orsted, and I believe Brongniart, were there at the time, and waited two days beyond it, till the two latter lost patience and set off, and Berzelius had his horses in his carriage when news was brought that the Englishman had arrived. And when they met, Davy's excuse was, "*that he had found such capital fishing by the way that he could not think of leaving it.*" The waiting and the excuse, conjoined with the hauteur which in later life made Davy forget most of his old friends, and his old friends dislike him, were sufficient to create an unfriendly feeling; so, after spending four hours together, they parted. "Any degree or mark of respect I was disposed to give him, as a great philosopher," said Berzelius;—"it was a pity to see a mind like his stoop to the demand of deference as a man of the world." Still was Davy

the greatest chemical philosopher that our days have seen, and when his little faults are forgotten, his merits and his discoveries will only be more highly appreciated. "He was the clearest-headed man," says Berzelius, "I ever met with, and he never wrote upon any subject without being interesting."

Of Wollaston in the North you hear nothing but praise. There is nothing to detract from his merit. The profound philosophy of his views, the nicety of his experimental investigations, and his amiable manners, are all highly estimated.

Having spoken of these three, I may add a word of the remaining British chemists. Of *Phillips* they tell you "he is a clever man, but fond of paradoxes;" and I have heard Berzelius speak in deservedly high terms of many of his papers. Of these I may mention among his later ones that upon the water in nitric acid of greatest concentration, which he admired as neat, conclusive, and elegant. Of *Faraday*, all have so much good to say, that it would be vain to particularize, and Berzelius holds him in the highest respect. *Turner* he esteems a clever man, and a very promising chemist. His papers in the last *Edinburgh Transactions* he considers to be both very excellent. Of his analysis of the Aerolite he says, "that it is the only meteoric iron that has ever been rightly analyzed," and that in consequence of the new and elegant method employed for separating the metals by the formation of a *bi*-carbonate. Of the elaborate paper on the ores of Manganese, he thus speaks in his last Arsberättlese (yearly statement), "One of the finest works of which mineralogy has to boast during the past year is Haidinger's and Turner's joint examination of the different ores of Manganese, in which the mineralogical and chemical parts are alike masterly, and by which this formerly obscure part of mineralogy is completely cleared up."

It would lengthen too much this already long paper to enter into any detail of the services rendered to science by Berzelius, or of his many chemical writings; but this is the less necessary, as every system of chemistry bears ample testimony to their extent and value, and every succeeding journal of science is adding to their number. In what I have above stated, are included many minutiæ which in the case of common men, we [illegible]ve been unworthy of being detailed; but

I have judged from my own feelings, in supposing that even trifles connected with such a man would have an interest for the cultivators, especially of chemical science; and should this paper ever meet the eye of Berzelius, I trust he will forgive me for teaching my countrymen to regard him as equally amiable in private life as they have long considered him distinguished in the chemical world.

PORTOBELLO, *4th January* 1830.

ART. II.—*Account of the apparatus and Incombustible Dresses invented by M. Aldini for Preserving the Body from the Action of Fire* *.

THE incombustible dresses of M. Aldini consist of two garments, the one being composed of a thick fabric of amianthus, or asbestos, or of wool rendered incombustible by impregnation with a saline substance; and the other of a fabric of wire gauze, which is placed without the first.

It is well known, from the fine experiments of Sir Humphry Davy, that wire gauze, with the meshes sufficiently narrow, completely intercepts flame, even when it is impelled by a great pressure, as in the case of an explosive mixture. This effect is produced by the cooling of the flame caused by the metal, and consequently cannot take place unless this last experience a rise of temperature proportional to the time that the flame continues in contact with the wire gauze.

This metallic garment, the mass of which is very inconsiderable, would not of itself be efficacious in defending the body from the action of heat; but the amianthus, or the impregnated woollen dress, opposes itself by its thickness and its feeble conducting power to the arrival of the heat at the surface of the body, and along with the metallic gauze it forms an impenetrable shelter during a time which ought to be sufficient for the operations of the firemen. The woollen dress is indispensable, and even more important than the metallic

* This article is the substance of M. Gay-Lussac's Report to the Academy of Sciences of Paris, printed in the *Ann. de Chimie*, tom. xlii. p. 214.

one, for there can be no doubt that on most occasions it would alone defend the fireman from the effects of heat.

It is with these two garments that M. Aldini first, and after his example a great number of firemen have confronted the most raging flames. The two following experiments were witnessed by the committee of the Academy.

A fireman, doubly enveloped in the incombustible and the metallic garments, presented his face to the flame of a straw fire, and he endured its action for a minute and twenty seconds. Another fireman, protected like the first, but having an additional piece of amianthus cloth on his front, resisted the flame during two minutes and thirty-seven seconds without suffering any pain. The pulse of the first rose from 80 in a minute to 120, and that of the second from 72 to 100.

This experiment, however, was only the prelude to another more imposing, viz. the passage of the firemen through flames for a distance of thirty-one feet.

Two parallel ranges of straw and small wood, supported by iron rods, were placed at the distance of about three feet three inches. When the materials were set on fire, the heat could not be endured at a less distance than eight or ten feet. The united flame of the two burning ranges rose to the height of nearly ten feet, and seemed to fill the whole space between the rows. At this time, six firemen, shielded by the apparatus of M. Aldini, and following one another at a short distance, run several times in succession through the burning space, the flame of which was kept alive by fresh additions of fuel. One of them carried a child, eight years old, in an osier basket, covered externally with wire gauze. The child had only a mask of the incombustible cloth. This experiment, which the assistants did not perform without a feeling of terror, had the most satisfactory result, and would have been regarded as completely decisive if it had been made in the middle of smoke. None of the firemen received any burns. The one who carried the child brought it back at the end of a minute in consequence of the cries of the child, who had been seized with terror in consequence of the fireman having too briskly swung him upon his shoulders. The child, however, had suffered nothing. The skin, when it came out of the

Besides, it is not difficult to retain the breath thirty or sixty seconds or even more; and though we do not think that the firemen employed this method when they ran through the burning ranges of flame, yet the short space of time necessary to run over thirty-three feet rendered it possible for them to do it.

But if it is demonstrated by the experiments which we have witnessed, that in the greatest number of cases, and in free air, respiration can be effected without danger, it is greatly to be feared that it will become very difficult in a narrow space filled with smoke, a case which happens very often in fires. In order that the fireman may breathe fresh air, will it not be necessary to furnish him with a portable reservoir, or what is more simple, with a spiral tube winding from his feet to his mouth? We know, indeed, that in an open and heated apartment, fresh air enters always below, while warm air escapes above, and consequently the firemen will thus have more chances of breathing freely. We insist upon this point, because we know that nothing disturbs respiration so much as thick smoke. We are of opinion also that it would be useful to accustom firemen to retain their breath,—an act which is acquired by divers.

We have said that M. Aldini employs in his apparatus amianthus cloth, and woollen cloth rendered incombustible by means of a saline solution. We shall now examine the advantages of each of these substances.

Amianthus, or asbestus, is, by its nature, perfectly incombustible. It is found in great abundance, particularly in Corsica; and Madame Lena Perpenti of Como has manufactured different fabrics of it, and even lace, (See *Bull. Soc. Encouragement*, 1813, p. 166.) so that there can be no doubt that this mineral is fitted for the different operations of spinning and weaving. M. Aldini has also been occupied in facilitating these operations, and he has presented to the commission a piece of amianthus cloth nearly six feet eight inches long, by five feet four inches wide, which is nearly as large as that which is preserved in the Library of the Vatican. This cloth, however, must always be of too great value to receive

numerous applications, and it is on this account that M. Aldini has sought to substitute for it a woollen cloth.

This cloth, even without saline impregnation, is but slightly inflammable, and on this account it ought to be used for the winter dresses of children in place of cotton cloth, the inflammability of which has occasioned so many distressing accidents; but when wool has been impregnated with sal ammoniac and borax it no longer burns. It merely calcines without propagating the combustion, and it is only penetrated slowly by heat. In this last respect it has even the advantage over amianthus, for when the finger is covered with amianthus cloth and presented to the flame of a candle, it receives sooner the impression of heat than when it is covered with the incombustible woollen cloth of the same thickness as that of the amianthus. Hence, in point of economy, in point of easy preparation; of commodious application; of greater lightness, and of less conductibility of heat, wool has the advantage of amianthus; and its resistance to fire, though incomparably less than that of this mineral, is still sufficiently great to support a high temperature, and to replace it in almost all the circumstances which are presented in fires.

The amianthus and woollen fabrics deserve particular attention, because they really form the most essential part of M. Aldini's apparatus. When employed alone they can defend the body in most cases from the action of flame and heat, whilst the metallic gauze, in extinguishing flame, does not sufficiently intercept the heat. This last material, by its great stiffness, has the great inconvenience of fettering the motions of the firemen, while it is of the greatest importance to them to preserve all their agility, and to be able to direct it with certainty. From these considerations we are of opinion that the woollen cloth, when sufficiently thick and close, and properly impregnated with saline solutions, or what is perhaps better still, when formed of several thinner fabrics superposed, but always so close as not to allow the passage of air, will alone have sufficient efficacy; and we are also of opinion, that it will be necessary in some circumstances to add moveable pieces of metallic gauze to defend those parts of the body which are the most exposed to suffer from heat, taking care to

leave between the two fabrics a certain distance; because a close contact renders the metallic gauze more injurious than useful.

Besides the garments of incombustible cloth and wire gauze, M. Aldini employs with great success large shields of metallic cloth. When these shields are presented by the firemen to a rush of flame, they stop it in a wonderful manner, and permit them to see their way and to climb up to places enveloped in flames, and to perform their operations. They form an useful supplement to the incombustible garments, and a defence to firemen who are not provided with the other parts of the apparatus. They occasion no embarrassment, but may be thrown aside or taken up at pleasure. Frames of metallic gauze, intended to intercept flame discharged at a door or any other opening, will likewise be of great service; but this is not the place to enter into a detail of all the applications which M. Aldini has made of the incombustible cloth and metallic gauze. This ingenious philanthropist is at present engaged in the preparation of a work, in which he will give an account of their various applications, with the necessary instructions for using them.

Remarks by the Editor.

In reference to the above essay, some objection may arise from the supposed scarcity of amianthus, and its insufficiency to answer the demand for such general use as is recommended. It may therefore be interesting to know, that amianthus occurs in a most remarkable quantity in the Island of Unst, one of the Shetland groupe. In the possession of Dr Hibbert, who first published an account of its great abundance in this locality, are specimens of this substance of a beautiful white colour, remarkable for the regularity and extent of its fibres, which exceed a foot, while some far longer may be collected. We are informed by him that it occurs in a very talcose serpentine rock in the vicinity of Haroldswick and Balta Sound, and in the diallage rock of Balta Island and other contiguous places.

ART. III.—*Chemical Examination of Wad.* By EDWARD TURNER, M. D., F. R. S. E., Professor of Chemistry in the University of London.* Communicated by the Author.

As the subject of this notice has never been found crystallized, and, from its aspect, appears to want that definite constitution which imparts so much interest to the analysis of most other minerals, it has hitherto been almost entirely neglected by chemists. I have myself been induced to examine it solely from its being enumerated among the ores of manganese, to which my attention has been much directed within the last two years; and my apology for introducing it to the notice of the Royal Society, is its connection with the essay on the oxides of manganese, which was honoured with a place in the last volume of their *Transactions*.

Under the name of Wad, or Black Wad, are comprehended several minerals, which are distinguished by the following characters:—They are soft, light, and porous, more or less earthy in appearance, of a brown colour, soil by contact, and contain manganese. Though they agree in these general points of resemblance, several of them are distinguishable from each other by physical properties, and differ essentially in chemical constitution.

First species. Wad from Upton Pyne in Devonshire.

For this Wad I am indebted to the kindness of Mr Konig of the British Museum. It occurs in a curved tabular mass about half an inch thick, and may be easily separated into thinner laminæ. It is easily broken, is considerably softer than gypsum, and soils when handled. Its colour is brown with a shade of yellow, somewhat like that of bismuth. The lustre of a fresh surface is considerable, and rather metallic. The streak is brown and shining. It consists of small scaly particles, arranged together so as to give to a broken surface a fibrous appearance. It is very porous, and emits numerous air-bells with a hissing noise when put into water. Its specific gravity, after being boiled in water, is 2.314.

* Read before the Royal Society of Edinburgh, 1st February 1830.

As the method of analysis is precisely similar to that so fully described in my former communication, it would be superfluous to enter minutely into particulars. The mineral dissolves readily in muriatic acid with evolution of chlorine, leaving only traces of insoluble earthy matter. The solution was completely free from iron, and, in addition to manganese, contained only a small quantity of baryta. Exposed to a red heat, after being well dried at a temperature of 212° F., it yielded 10.66 per cent. of water, together with some oxygen. At a white heat it lost 19.48 per cent.; namely, 10.66 of water, and 8.82 per cent. of oxygen. The baryta, precipitated in the usual manner by sulphuric acid, amounted to 1.4 per cent.—According to this analysis, 100 parts of the mineral were resolved into

Red oxide of manganese, -	79.12
Oxygen, - -	8.82
Water, - -	10.66
Baryta, - -	1.40
	100.00

The essential ingredient of the mineral, inferred from these numbers, appears to be a hydrated peroxide of manganese, consisting of 88 parts or two equivalents of peroxide, and 9 parts or one equivalent of water,—a compound which, to my knowledge, has not been observed in the mineral kingdom. Were such a compound quite pure, the analysis should have given the following proportions:—Red oxide 79.12, oxygen 10.57, and water 9;—that is, rather less water and rather more oxygen than was actually obtained. A slight excess of water must of course be looked for; because the heat of 212° cannot be expected to disengage all the humidity adhering to a light earthy powder. A deficiency in oxygen is also to be expected. For the baryta which the mineral contains, and which I shall show to be an accidental admixture, is not in its ordinary state of combination, but is united with some oxide of manganese. What that oxide is, has not yet been determined with certainty; but in three minerals in which I have detected a composition of this nature,—namely, in a Wad to

be presently described, and two minerals noticed in my former communication,—the baryta is unquestionably united with an oxide of manganese less highly oxidized than the peroxide. The presence of such a compound in the Derbyshire Wad will readily account for the oxygen being somewhat less than theory requires.

The hydrated peroxide of manganese may thus be regarded as the essential ingredient of the Derbyshire Wad, and, according to my observation, is the most frequent variety of this mineral. I have not met with it in a state of perfect purity. It usually contains small quantities of some other oxide of manganese, together with baryta, oxide of iron, lime, and silica.

Mr Konig has kindly supplied me with two other varieties of this Wad, one from Hüttenberg in Carinthia, and the other from the district of Nassau. They agree with the Derbyshire wad in all their physical properties, except in the small micaceous particles being less compacted together, and the fibrous arrangement being more distinct. They yield also by analysis similar quantities of red oxide of manganese, oxygen, and water. They both contain traces of silica and baryta; and a little lime was detected in the latter. A variety of Wad from the neighbourhood of Elbingerode in the Harz, sent me by Professor Hausmann of Göttingen, under the name of *schaumiges* or frothy Wad, belongs to the same species. The greater part of it was in powder; but the cohering particles had the same physical characters as the preceding. It is identical also in chemical constitution, and contains traces of siliceous matter, baryta, and oxide of iron. I have received another variety of the same mineral, under the name of *earthy ochreous Wad*, from Professor Stromeyer. It occurs in the district of Nassau; and though essentially identical with the preceding varieties, is much less pure. It is visibly intermixed with the hydrated red oxide of iron, and when dissolved in muriatic acid leaves a considerable quantity of earthy insoluble matter.

Second species. Wad from Derbyshire.

This Wad, for which I am indebted to Mr Konig, is earthy without the slightest crystalline appearance. It acquires a slight lustre by friction, but is otherwise dull. It is very soft

and friable, and soils when handled. Its streak and powder are of a reddish-brown colour. It absorbs moisture greedily on being wetted, and when put into water emits numerous globules of air with a hissing noise. Its specific gravity, after its contained air is expelled, is 3.024. It separates readily into parallel layers, the natural joinings being formed by thin strata of hydrated peroxide of iron, which is largely and intimately mixed with the wad, so as not to be separable from it.

The Derbyshire Wad, when digested in muriatic acid, leaves a white residue, chiefly consisting of sulphate of lime, which is interspersed in minute crystals through the mineral. Its quantity is variable; but in the portion submitted to analysis it amounted to 2.74 per cent.

The clear solution in muriatic acid was strongly coloured with iron, and on the addition of sulphuric acid yielded a quantity of sulphate of baryta, corresponding to 5.40 of pure baryta. The liquid was then exactly neutralized, and the iron precipitated by benzoate of ammonia. The filter containing the benzoate of iron was put into a platinum crucible, a few drops of nitric acid and solution of nitrate of ammonia were added, the paper after being dried by a sand heat was burned, and the residue ignited. By this means the benzoic acid and filter may be decomposed without deoxidizing any of the peroxide of iron. The resulting peroxide, which was not in the slightest degree attracted by the magnet, amounted to 52.34 per cent.

From the solution, thus freed from baryta and iron, the manganese was thrown down by potash, and a quantity of red oxide obtained equivalent to 38.59 per cent. of deutoxide. —The solution also contained a trace of lime.

Carefully dried at 212°, and exposed to a red heat, it lost 10.29 per cent. of water. No oxygen was expelled by that temperature, showing that the manganese is not in a higher state of oxidation than the deutoxide. It appears, accordingly, that this variety of Wad, besides oxide of iron and water, contains a compound of baryta and deutoxide of manganese, apparently similar to that constituting the essential ingredient in the uncleavable ore of manganese, and which is present in small quantity in the Devonshire Wad.

The iron contained in the Derbyshire Wad is wholly in the state of peroxide. The grounds from which I infer the entire absence of the protoxide it may not be superfluous to state, as the method appears to me fully more delicate than any in use. It is founded on a fact, which I have elsewhere adverted to for another purpose,* that the formation of Prussian blue from prussic acid by admixture with a salt of iron and potash, does not occur when the iron is strictly in its maximum of oxidation. A very minute quantity of the protoxide, however, gives rise to the production of Prussian blue, which is rendered obvious by dissolving the precipitated oxide by a slight excess of sulphuric acid.—The Derbyshire Wad digested in dilute sulphuric acid in a close vessel yielded a yellow-coloured solution, which, when mixed with prussic acid, precipitated by pure potash, and acidulated with sulphuric acid, did not give the least tint of blue.

When this Wad is exposed to a white heat it loses 18.34 per cent.; namely, 10.29 of water, and 8.05 of oxygen. The residue was much contracted, of a black colour, and was powerfully attracted on the approach of a magnet. It is hence manifest that the oxygen was derived as well from the peroxide of iron as from the manganese. A similar change ensues when a mixture of pure peroxide of iron and oxide of manganese is exposed to a red heat.

According to the foregoing analysis, 100 parts of the Derbyshire wad were resolved into

Peroxide of iron, - -	52.34
Deutoxide of manganese, -	38.59
Water, - -	10.29
Baryta, - -	5.40
Insoluble earthy matter -	2.74
	99.36

The Wad from the Harz, of which Klaproth has given an analysis in the 3d volume of his *Contributions*, appears to have been of the same nature as the preceding; but it contained a greater proportional quantity of manganese and baryta.

Third species of Wad.

* *Edin. Med. and Surgical Journal*, xxx. 344.

Another species of Wad, of the exact locality of which I am ignorant, was lately sent me from Germany, under the name of *ochreous Wad*, by Professor Hausmann. It is a friable earthy substance, like the foregoing species; but the colour of its streak and powder is dark or blackish brown. It is very porous, and emits a copious stream of air-bells when put into water. Its specific gravity is 4.506.

On exposure to a red heat, after being dried at a temperature of 212° F., it loses 3.08 per cent. of water, together with oxygen gas. Its loss at a white heat amounted to 12.755 per cent.; namely, 3.08 of water, and 9.675 of oxygen. In muriatic acid it is readily dissolved with free disengagement of chlorine, leaving merely traces of insoluble matter. The solution was free from lime and iron, but contained a trace of baryta. Considering its high specific gravity, the small quantity of combined water, and the large quantity of oxygen, which it loses at a white heat, there cannot be a doubt that this species of wad consists essentially of the anhydrous peroxide of manganese, with which a small quantity of some hydrated oxide, probably manganite, is casually intermixed.

ART. IV.—*Account of a remarkable case of Spectral Illusion, in which both the Eye and the Ear were influenced.* * In a Letter to the EDITOR.

THOSE who have read Dr Hibbert's admirable work on the *Philosophy of Apparitions*, and have appreciated the ingenious views which he has taken of this remarkable class of mental phenomena, will peruse with double interest the very singular case of spectral illusion which forms the subject of this paper.

It was communicated to me by the gentleman whose lady was under its influence, and who was himself present during the whole progress of the illusion which affected the eye. Were I permitted to mention his name;—his station in society, and as a man of science, would authenticate the minutest particulars in the following narrative, and satisfy the most scrupulous reader that the case has been philosophically as well as faithfully described. The gentleman and lady, indeed, were

* Since this [illegible] types we have received another interesting case, which [illegible] quent article in this Number.—ED.

previously well aware of the existence and nature of this class of facts, and, so far from regarding the present case as at all supernatural, or even out of the ordinary course of things, they watched it from its commencement as a case of spectral illusion, and have therefore impressed upon the narrative a character which does not belong to any previous case where the patient and the narrator were the same person.

"On the 26th of December 1829, about half-past four in the afternoon, Mrs ——— was standing near the fire in the hall, and on the point of going upstairs to dress, when she heard, as she supposed, my voice calling her by name, '——— ——— Come here, come to me.' She imagined that I was calling at the door to have it opened, went to it, and was surprised on opening it to find no one. She returned towards the fire, and again heard the same voice calling very distinctly and loud '——— Come, come here.' She then opened two other doors of the same room, but seeing no one, she returned to the fire place. After a few moments, she heard the same voice still calling, '——— ——— Come to me, come, come away;' this time in a loud, plaintive, and somewhat impatient tone. She answered as loudly, 'Where are you? I don't know where you are,'—still imagining that I was somewhere in search of her; but receiving no answer, she shortly went up stairs. On my return to the house about half an hour afterwards, she inquired why I had called to her so often, and where I was; and was of course surprised to hear I had not been near the house at the time.

"On the 30th of the same month, at about 4 o'clock P. M. Mrs ——— came down stairs into the drawing-room, which she had quitted a few minutes before, and on entering the room, saw me, as she supposed, standing with my back to the fire. She addressed me, asking how it was I had returned so soon. (I had left the house for a walk half an hour before.) She said I looked fixedly at her with a serious and thoughtful expression of countenance, but did not speak. She supposed I was busied in thought, and sat down in an arm-chair near the fire, and close within a couple of feet at most of the figure she still saw standing before her. As, however, the eyes still continued to be fixed upon her, after a few minutes she said 'Why don't you speak ———?' The figure upon this moved off towards the window at the further end of the room, the eyes still

gazing on her, and passed so very close to her in doing so, that she was struck by the circumstance of hearing no step nor sound, nor feeling her clothes brushed against, nor even any agitation in the air. The idea then arose for the first time into her mind, that it was no reality, but a spectral illusion, (being a person of sense and habituated to account rationally for most things, the notion of any thing supernatural was out of the question.) She recollected, however, your having mentioned that there was a sort of *experimentum crucis* applicable to these cases, by which a genuine ghost may be distinguished from one conjured up by merely natural causes; namely, the pressing the eye in order to produce the effect of *seeing double*, when, according to your assertion, a true Tartarean ghost would be duplicated as well as every thing else; while the morbid idea being, I suppose, an impression on the retina would, or ought to remain single. I am sorry, however, to say that the opportunity for verifying your theory was unfavourable. Before Mrs ——— was able distinctly to double her vision, my figure had retreated to the window, and disappeared there. The lady followed, shook the curtains, and tried the window, being still loth to believe it was not a reality, so distinct and forcible was the impression. Finding, however, that there was no natural means of egress, she became convinced of having seen a spectral apparition, such as are recorded in Dr Hibbert's work, and consequently felt no alarm or agitation. The appearance lasted four or five minutes. It was bright day-light, and Mrs ——— is confident that the apparition was fully as vivid as the reality; and when standing close to her it concealed, of course, the real objects behind it. Upon being told of this my *visible* appearance in the spirit, having been only *audible* a few days before, I was, as you may imagine, more alarmed for the health of the lady than for my own approaching death, or any other fatality the vision might be supposed to forebode. Still both the stories were so very much *en regle* as ghost stories, the three calls of the plaintive voice, each one louder than the preceding, the fixed eyes and mournful expression of the phantom, its noiseless step and spirit-like vanishing, were all so characteristic of the *Wraith*, that I might have been unable to shake off some disagreeable fancies, such as a mind once deeply saturated with the poison of nursery-tales

cannot altogether banish, had it not been for a third apparition, at whose visit I myself assisted a few days afterwards, and which I think is the key-stone of the case, rendering it as complete as could be wished.

"On the 4th of this month (January 1830) five days after the last apparition, at about ten o'clock at night, I was sitting in the drawing room with Mrs ——, and in the act of stirring the fire, when she exclaimed 'Why, there's the cat in the room.' I asked 'Where?' She replied 'There close to you.' 'Where?' I repeated. 'Why, on the rug to be sure, between yourself and the coal-scuttle.' I had the poker in my hand and I pushed it in the direction mentioned. 'Take care,' she cried out, "take care, you are hitting her with the poker." I again asked her to point out exactly where she saw the cat. She replied, 'Why, sitting up there close to your feet on the rug:—she is looking at me. It is Kitty. Come here, Kitty.' There are two cats in the house, one of which went by this name. They were rarely, if ever, in the drawing room. At this time Mrs ——— had certainly no idea that the sight of the cat was an illusion. I asked her to touch it. She got up for the purpose, and seemed as if she was pursuing some thing which moved away. She followed a few steps, and then said, 'It has gone under that chair.' I told her it was an illusion. She would not believe it. I lifted up the chair, there was nothing there, nor did Mrs ——— see any thing more of it. I searched the room all over, and found nothing. There was a dog lying on the hearth who would have betrayed great uneasiness had a cat been in the room. He was perfectly quiet. In order to be quite certain, however, I rung the bell, and sent for the two cats. They were both found in the housekeeper's room. The most superstitious person could now doubt no longer as to the real character of all these illusory appearances, and the case is so complete that I hope there will be no renewal of them, symptomatic as they of course are of a disordered state of body. I am sorry to say Mrs ——— as well as myself, forgot to try in time the *experimentum crucis* on the cat.

"Mrs ——— has naturally a morbidly sensitive imagination, so strongly affecting her corporeal impressions, that the

story of any person having suffered severe pain by accident or otherwise, will occasionally produce acute twinges of pain in the corresponding parts of her person. An account, for instance, of the amputation of an arm, will produce an instantaneous and severe sense of pain in her own arm, and so of other relations. She is subject to talk in her sleep with great fluency, to repeat poetry very much at length, particularly when unwell, and even to *cap verses* for half an hour together, never failing to quote lines beginning with the final letter of the preceding, till her memory is exhausted.

"She has, during the last six weeks, been considerably reduced and weakened by a tiresome cough, which has also added to her weakness, by preventing the taking of a daily tonic, to which she had been for some time accustomed. She had also confined herself from this cause to the house for some weeks, which is not usual with her, being accustomed to take a great deal of air and exercise. Her general health has not been strong for some time past, and a long experience has proved, beyond a doubt, that her ill health is attributable to a disordered state of the digestive organs. These details are necessary for a complete understanding of this case, which strikes me as being one of remarkable interest, from combining the characters of an ordinary ghost story with those of an indubitable illusion; as well as from the circumstance occurring to a person of strong mind, devoid of any superstitious fancies, and to be implicitly relied on for the truth of all the minutest details of the appearances. Indeed, I do not recollect any well authenticated and recent instance of *auricular* delusion like the first of those I have related; though, of course, the warning voices and sounds which have frightened so many weak persons into their graves, must have been of this nature. Mrs ——— tells me, that about ten years ago a similar circumstance happened to her when residing at Florence, and in perfect health. While undressing after a ball, she heard a voice call her repeatedly by name, and was at that time unable to account for the fact.*

January 10, 1830.

* Since sending this remarkable account to press, the Editor transmitted a printed copy of it to Dr Hibbert, who unites with him in his opinion

ART. V.—*Distinctive properties of Thorina and its Salts.* Communicated by the Translator.

IN a former Number (No. ii. New Series, p. 207,) we gave the general properties of this new earth as stated by Berzelius. The following are its *distinctive* properties, and those of its salts from his paper in the *Transactions of the Swedish Academy.*

Thorina is distinguished generally from the other earths by its forming with sulphuric acid a compound, which, by boiling, lets fall a white salt, dissolving again, though slowly, on becoming cold. In applying this test, however, it must be remarked, that this precipitation is prevented by the presence of those bases with which thorina forms double salts, from which, by boiling, no appreciable quantity falls.

From *alumina* and *glucina* it is distinguished by its being insoluble in caustic potash, by which these earths are taken up.

From *yttria*, by its forming with sulphate of potash a double salt insoluble in a saturated solution of sulphate of potash, by which means it may sometimes be separated *quantatively* from *yttria.*

From *zirconia* by these two circumstances, that zirconia precipitated hot by sulphate of potash, becomes afterwards, in a great degree, insoluble both in water and acids; and that thorina is precipitated by the cyanide of iron and potassium, by which the salts of zirconia are not troubled.

From *protoxide of cerium* by these,—that in drying and heating to redness, it does not assume the colour of the peroxide of cerium,—and that, before the blowpipe with borax and phosphor-salt, it does not give a coloured glass, either

of its importance, as one of the most interesting pathological instances of the kind which has yet been published; and which, from the truly philosophical spirit in which it is narrated, he considers as deserving to be ranked with the celebrated case of Nicolai. He conceives that the association of spectral illusions with that intense state of sympathetic feeling by which an account, for example, of the amputation of an arm will produce an instantaneous and severe sense of pain in the lady's own arm, as a striking feature in the case, and as calculated to throw additional light upon the theory of spectral illusions; no observations to the same effect having, to his knowledge, been before published. We are promised a few remarks on the subject in a future Number.

when hot or cold, provided the earth has been previously perfectly free from oxide of iron.

From *titanic acid* as well by its precipitating with sulphate of potash, as by the characteristic properties of titanic acid before the blowpipe.

From the *common metallic oxides*, among which, from its high specific gravity, it might be ranked by its not being precipitated by sulphuretted-hydrogen.

The properties which it possesses in common with the sub-phosphate of yttria are the following:—1*st*, Its salts have a pure astringent taste. 2*d*, The crystallized sulphate treated with warm water becomes opaque, and leaves a white skeleton of the crystalline form. 3*d*, Most of its salts are precipitated by boiling, and attach themselves strongly to the sides of the glass, like a white enamel. 4*th*, Its hydrate strongly attracts carbonic acid from the air while drying. 5*th*, And dissolves in carbonated, but not in caustic alkalies. 6*th*, And the solutions of both are precipitated by prussiate of potash, &c. But it is easily distinguished from yttria both by the above-mentioned test, and by this,—that the chloride of thorium is not thrown down by boiling, like a solution of sub-phosphate of yttria in muriatic acid.

Salts of thorium. The salts which thorium gives, as well with *salt formers*,* as in the state of oxide with the oxy-acids, are distinguished by a strong and pure astringent taste, which is not accompanied by any thing of sour, sweet, or bitter, and which most resembles that of pure tannin. In taste they also resemble nearest the salts of zirconium. Their solutions are precipitated by oxalic acid, and by the cyanide of iron and potassium, of a white colour; and are rendered muddy by sulphate of potash, which is dissolved by them.

These three reagents distinguish them from all other unmixed salts except those of the protoxide of cerium, from which salts they are distinguished by this,—that the colourless precipitate by caustic alkali does not become yellow in the open air as is the case with the cerium salts. The salts of

* The following are what Berzelius calls *Salt bildare, salt-builders*, chlorine, iodine, bromine, cyanogen, fluorine, and sulpho-cyanogen, the base of the hydro-sulpho-cyanic acid.—Translator.

thorina are decomposed by a red heat, and leave the earth in an isolated state, and they lose their acids more easily than zirconia.

Art. VI.—*On the Magnetic Influence of the Solar Rays.* By MM. P. Riess and L. Moser.

The observations of Mrs Somerville, (published in this *Journal*, No. viii. p. 328,) tended to confirm the magnetic influence of the violet rays. This action, discovered by M. Morichini at Rome, and described by him a long time ago, had been called in question by the natural philosophers of France, Germany, and Italy. Yet the favourable result to which Mrs Somerville had arrived, seemed to have so completely dissipated these uncertainties, that, upon that discovery, various theories have been started respecting the magnetism of the earth and its annual and diurnal variation. It cannot be concealed, that the magnetic action of the sun does not afford an easy explanation of them. The labours of Baumgartner on the same subject,—the observations of Mr Christie on the diminution of the amplitudes of a needle oscillating in the solar rays, which seem to connect the magnetic action of the sun with a recent discovery,—and, finally, an experiment of M. Zantedeschi at Pavia, about to be published, have induced us to communicate the results and researches which we have undertaken, to illustrate so important a point.

In limiting ourselves to a minute repetition of the methods described by M. Morichini and his successors as the most favourable, we have, however, abandoned the methods which they employed for appreciating the magnetic state of the needles, and for measuring its intensity; for anterior trials had assured us that they were subject to errors almost unavoidable. The most certain method of judging of the magnetism of a needle consists in making it oscillate; and this is the method which we have employed. The needles were of soft steel. Their mass was very small, but they presented a considerable surface to the action of the light. We were satisfied of the primitive state of these needles, as far as their

magnetic intensity was concerned, by examining them some time before using them; and it was by this means that we obtained decided results. The feeble magnetism of needles of soft iron perhaps never reaches a fixed state. On this account we have not given in the following tables the numerical results obtained with this sort of needles. It may be sufficient here to remark, that none of them, in the different circumstances in which we exposed them, acquired, by the action of light, a decided magnetism; and that this might as well be attributed to the variations which that property undergoes in iron by all sorts of influences even mechanical ones.

With regard to the following tables, we may add, that the spectrum was almost always in its minimum of deviation, (that is, the rays entered and emerged at equal angles from the two surfaces of the prism,) which corresponds to its greatest intensity;—that the needles were placed upon a graduated circle, three or four feet from the prism; that the room was in most cases darkened as little as possible; and that the lens had an aperture of 1.2 inches, and a focal length of 2.3 inches.

Dates.	Names of the needles.	Duration of Oscillations. Before expt.	After expt.	Time of Observation.	
April 3,	*a*	22″.0	22″.0	$10\frac{1}{2}^h$	12^h
27,	*b*	27 .5	27 .5	$9\frac{1}{2}$	11
	c	14 .5	14 .5	$9\frac{1}{2}$	11
May 6,	*d*	3 .0	3 .0	$8\frac{1}{2}$	10
June 14,	*e*	15 .2	15 .7	9	12
16,	*f*	22 .0	22 .0	$9\frac{3}{4}$	$11\frac{3}{4}$
17,	*f*	22 .7	22 .5	$8\frac{3}{4}$	$11\frac{3}{4}$
23,	*g*	18 .2	18 .2	9	$10\frac{3}{4}$
July 1,	*f*	23 .0	23 .7	$9\frac{1}{4}$	$12\frac{1}{4}$
1,	*h*	19 .5	19 .5	$9\frac{1}{4}$	$12\frac{1}{4}$
11,	*f*	22 .4	22 .2	$8\frac{1}{2}$	$10\frac{3}{4}$
11,	*i*	27 .7	22 .5	$8\frac{1}{2}$	$10\frac{3}{4}$
25,	*f*	19 .5	19 .2	$9\frac{1}{4}$	11
Aug. 10,	*f*	22 .0	22 .2	9	12
10,	*k*	20 .2	20 .0	9	12
12,	*f*	22 .2	22 .2	9	$11\frac{1}{2}$
12,	*l*	17	16 .7	9	$\frac{1}{2}$

In all these experiments the focus of the violet ray was made to traverse one-half of the needle 200 times, excepting on the 11th July and 12th August, when it was done only 100 times, and on the 25th July, when it was done 525 times.

In the experiments with the needles *a*, *b*, *c*, the spectrum was fixed by means of a heliostate. By this means it was protected against the agitations which the motion of the sun and the displacement of the needles rendered inevitable. We did not, however, always use this instrument, because, in the experiments which we wished to verify, no mention was made of the action of *reflected* light. It is proper to observe, that the needle had been exposed $17\frac{1}{2}$ hours to the action of the sun without becoming magnetic, though M. Morichini required only from fifteen to thirty minutes for completely magnetising it.

In order to ascertain that the magnetism had not undergone any change while the needles remained in the violet light, we suspended, in a small earthen vessel, a needle strongly magnetised and *two* inches long, and whose south pole (that is the pole directed to the south of the earth) oscillated before the needle under experiment, fixed vertically and submitted to the action of a violet ray, which the heliostate rendered immoveable. The following were the results:

			Alone.	Before the needle.
Hour of day	$10\frac{1}{4}$	duration of oscil.	50″.2	48″.7
	11^h 3			48 .7
	12		50 .2	48 .7

In order to repeat the experiments of M. Baumgartner, (*Zeitschrift*, tom. i. p. 263,) which the magnetic action of the sun presents under another form, we took steel wires from 3 to 3.4 inches long, and 0.04 in diameter, polished in different parts, and we fixed them vertically before and after each experiment, before the north pole of the small trial needle, situated in the cylindrical tube, and oscillating. We could thus bring the latter to different heights of the steel wires. The numbers in the third column refer to the length of these wires reckoned vertically.

Dates.		State of the part of the needle.	Height in inches.	Duration of oscillations. Before expt.	After expt.
June 12,	*a*	polished,	0. 1	54″.0	53″.8
		oxidated,	1.24	49 .6	49 .6
		polished,	2.43	48 .8	48 .8
13,	*b*	polished,	0.23	54 .0	54 .4
		oxidated,	1.33	49 .6	49 .6
		oxidated,	2.49	47 .6	47 .6
	c	polished,	0.25	53 .6	53 .6
		oxidated,	1.35	49 .6	50 .0
		polished,	2.62	46 .4	46 .4
23,	*d*	oxidated,	0.35	52 .0	52 .0
		polished,	1.79	48 .0	48 .8
		oxidated,	2.97	50 .0	49 .4
26,	*c*	polished,	0.35	53 .6	53 .6
		oxidated,	1.72	48 .8	49 .2
		oxidated,	3.03	46 .4	46 .4

In the experiment of June 12th, the needle was exposed to the direct solar light from $9\frac{1}{4}^{h}$ to $1\frac{3}{4}$; in that of the 13th, from $8\frac{3}{4}$ to $12\frac{1}{4}$; and in that with *c*, from 9 to $12\frac{1}{4}$; in that of the 23d, from 9 to $1\frac{1}{4}$; and in that of the 26th, from $8\frac{1}{2}$ to $1\frac{1}{2}$.

We have since employed half polished wires, whose change of magnetic condition is easily known by the duration of a sufficient number of oscillations.

Dates.		Duration of oscillations. Before expt.	After expt.	Time of exposure.	
July 2,	*a*	35″.2	35″.0	$9\frac{1}{4}^{h}$	12^{h}
	b	20 .7	21 .0		
11,	*c*	28 .4	29 .0	$8\frac{1}{4}$	1
	d	20 .4	20 .6	$9\frac{1}{4}$	$12\frac{1}{2}$
24,	*e*	26 .2	26 .0	9	1
26,	*f*	36 .0	37 .0	$8\frac{1}{2}$	$1\frac{3}{4}$
	d	20 .0	20 .0		
	g	32 .6	32 .6		
Aug. 5,	*h*	22 .8	22 .6	$8\frac{3}{4}$	$1\frac{1}{2}$
10,	*i*	38 .2	38 .4	$8\frac{3}{4}$	$12\frac{1}{2}$
26,	*k*	32 .1	32 .0	8	$11\frac{3}{4}$
27,	*l*	30 .	31 .4	9	$11\frac{1}{2}$
	n	31 .7	32 .0	$9\frac{1}{2}$	$1\frac{1}{2}$

In all these experiments the magnetism of the polished extremity of the wire was *North*, excepting with the needles *c* and *g*, in which it was *South*; the focus of a lens was directed upon the needles during ten minutes, excepting in the experiments on the 11th July with wire *d*, when it was 25′, and that with wire *l*, when it was only 5′.

In order to show the state of the wires during the solar action, we fixed vertically the south pole below and the polished half above the trial needle. The following experiment was made in this manner on the 12th August:

			Alone.	Before the wire.
Hour of day	$9\frac{3}{4}$ h	Duration of oscill.	39″.5	42″.0
	10 40′			42 .0
	10 50			42 .0
	12 25		39 .5	42 .0

M. Poggendorf recommended to us to extend our experiments to polarised light. For this purpose we sometimes employed a blackened mirror inclined 35° 25″ to the incident solar ray, and sometimes a prism of calcareous spar. The observations on this kind of light will be found in our memoir. It may be sufficient to state here, that it did not prove more efficacious than direct light on the production of magnetism.

From this analysis of our researches we think we are justly entitled *to reject totally a discovery, which, for seventeen years, has at different times disturbed science.* The small variations which are found in some of our experiments, and which we have not concealed, cannot constitute a real action of the nature of that which was observed by MM. Morichini, Baumgartner, &c. in so clear and decided a manner. These variations, besides, are not always favourable to the supposed discovery.—*Ann. de Chimie.*

Art. VII.—*On the Influence of Electricity on Animal Putrefaction.* By Charles Matteucci.

Animal substances, withdrawn from the influence of life, quickly undergo a change, and exhale fetid gas previous to their destruction. Air, water, and heat, are the external causes which give rise to this new order of compositions. Water contributes to it by softening the fibres and by uniting itself to the products of putrefaction: heat, when it is moderate, separates them, and by destroying their cohesion, disposes them for new combinations: air exercises the most marked influence by yielding a part of its oxygen to the carbon, the hydrogen and the azote of the animal substances; hence comes the carbonic acid, water, carbonate of ammonia, and the acetic acid, which are the principal products of animal fermentation. The animal fibre then suffers this change, principally on account of the oxygen of the atmosphere which combines with it; and consequently, by taking away the action of the oxygen, we may, in this respect, prevent putrefaction. Nothing, however, is more easy than to change the affinities of bodies, and, for this purpose, it is sufficient to change their electric state. Setting out, from these principles, Sir H. Davy made his fine and useful discovery for preventing the oxidation of copper which sheaths the hulls of vessels. By thus considering oxygen as a body eminently electro-negative, we may prevent its combination with the animal fibre by establishing in them an analogous electric state, that is, a state of negative electricity.

Persuaded from some experiments of M. Bellingeri of Turin, and others not yet published which I have myself made, that animal substances, when they are put in contact with metals, establish themselves in an electric state, I determined to place some pieces of muscle upon plates of zinc, others on plates of copper, and I left others by themselves. In the course of a day I perceived that putrefaction had already begun in the pieces of muscle which were left to themselves, while no alteration showed itself in those which were in contact with metals. I afterwards perceived that the products of

the change which had afterwards taken place on these last were different, but were always related to the electric state which they had assumed, that is, with their affinity. I observed, for example, ammoniacal products, and those of carbonated hydrogen in the muscles which were in contact with the zinc; and much acid and acetate of copper in those which were in contact with the copper. These results prove sufficiently that muscle, put in contact with zinc, having become electro-negative, and being no longer able to unite with the oxygen, have been slow in decomposing; but have at last yielded to the affinity, though weak, of the hydrogen and the azote, while, on the contrary, the muscular fibre, placed on copper, were combined entirely into acid products. We may then, in this manner, retard putrefaction, that is, by eluding the action of one of the two elements of the atmosphere. I have thus obtained similar and perhaps more marked results by determining an electric state in the animal fibre, not by electro-motive action, but by placing them as conductors at the poles of a pile.

By setting out with these considerations, it appears to us that we may, with more certainty, explain the antiseptic property of some bodies, an explanation, however, which is not the same for all. There are some, for example, which act by taking away water; others by forming true imputrescible combinations; others, in my opinion, by determining a particular electric state. Of this kind is the property of vegetable charcoal. It is a settled fact in practical surgery, (as has been shown by Dr Palman in a pamphlet lately published in Paris) that if we put vegetable charcoal on purulent sores and on putrid sores, it is not long in depriving them of their bad smell, and preventing the ulterior developement of fetid matter.

Effects like these cannot depend solely on the action of porosity, for they would cease by continued contact; and we may explain them better by regarding the action of charcoal as electrical, in consequence of which, by establishing in purulent sores, and in putrid flesh, electrical states, they lose those affinities in virtue of which they separate the purulent matters, or destroy them by a rapid putrefaction.—*Ann. de Chimie.*

ART. VIII.—*Memoir on an Analogy which exists between the propagation of Light and that of Electricity, or on the constancy of the effects of electric currents forced to traverse spaces already traversed by other electric currents.* By Dr ET. MARIANINI, Professor of Natural Philosophy at Venice.

AMONG the admirable properties with which light is endowed, one of the first is certainly the extraordinary rapidity with which it is propagated; a property which, combining with the subtilty of its particles, produces very probably that other faculty, not less astonishing, in virtue of which the rays cross each other in their route without undergoing the slightest alteration.

We know, that on placing the eye at a small hole, before which is extended a vast space on which is disseminated a number and variety of objects, how distinctly they are seen. This experiment clearly shows in what manner a prodigious number of luminous rays may meet in a very small space without experiencing a sensible collision. A phenomenon of the same kind, and even still more surprising, may be produced by means of concave mirrors. Place two together in such a manner that their optical axes intersect each other reciprocally, and put before one of them any object, a red ball for instance, in such a situation that the mirror reflects the image to the place where its axis meets with the axis of the other mirror. Place before the second mirror a different object, a green ball for instance, in such a manner that its image exactly strikes the place where the axes cross each other. If the observer then directs his attention towards the first mirror, and looks along the axis of it, he will perceive the image of the red ball; directing his eye then towards the axis of the second mirror, he will see the image of the green ball precisely in the same place where he had before seen the red ball. This experiment plainly shows the manner in which the luminous rays, proceeding from two different objects, can cross each other reciprocally without experiencing the slightest alteration.

Since then electricity is not inferior to light in the facility

of its propagation, will it also present a phenomenon analogous to that which we have described?

As I am not aware that any one has drawn a similar conclusion, and made it an object of particular study, and as I conceive also that nothing can now be considered useless that concerns the science of electricity, I have not looked upon it as a trivial occupation to make several experiments, in order to try if the effects of electric currents can be altered when they are obliged to traverse spaces which are already crossed by other electrical currents.

1. Beginning with the most simple cases, those in which two electric currents cross each other at right angles, I took a cube of wood three centimetres in the side, the four faces of which, in parallel pairs, were furnished in their centre with a screw, fixing a rectangular plate of metal eight centimetres in length, and rather less than two centimetres in breadth. Wishing, in my first experiment, to put in opposition, two electric currents produced by two equal elementary batteries, I applied against one of the faces of the cube a plate of zinc, and against the opposite face a similar plate of copper, and I made them communicate by pressing under the screws which fixed them, the ends of the exciting wire of a galvanometer. The two plates presented on the same side of the cube a projection of about six centimetres. This pair being plunged to the depth of five centimetres in water slightly salted, the needle of the galvanometer deviated twelve degrees. To the two other faces of the cube furnished with screws, I fixed in the same manner two similar plates, the one of zinc and the other of copper, and I put them in communication by pressing under the screws which supported them the ends of an exciting wire. The four plates stretched beyond the same base of the cube by an equal quantity. Things being thus prepared, I plunged the two pairs in the fluid abovementioned, and the deviation of the needle was again twelve degrees. We see by this experiment, that the effect of a pair of plates upon the magnetic needle is not altered, when the electric fluid which it causes to circulate is forced to traverse a fluid which is crossed in a direction perpendicular to its own by an electric current created by a pair of plates equal to the first.

In place of a pair of plates communicating with the wire of the galvanometer, I substituted another much more weak, formed like the preceding of two plates, equal in dimensions to the first, one of *tin*, and the other of *brass*. I withdrew the exciting wire which put the two other plates in communication. As in the preceding experiment, I tried the electro-magnetic effect. I obtained a deviation of about three degrees. I restored the exciting wire to the *zinc* and *copper* plates, and renewed the experiment. The effect was the same.

The results obtained from other similar experiments, in which oppposite electric currents act, produced by two elementary Voltaic apparatuses, either of equal or different power, by employing fluids endowed with a greater or less conducting faculty, present the same fact. With the intention of crossing two currents, one produced by an elementary apparatus, and the other by a compound apparatus, I removed from the cube the two plates of copper and zinc, put in communication by means of the exciting wire. I substituted two similar plates of brass. I made one communicate with the positive pole, and the other with the negative pole of an apparatus *à couronne de tasses*, of twenty pairs, in each of which the active surface was about six centimetres square. The elementary battery in communication with the galvanometer, was formed of two plates, the one of *zinc*, the other of *lead*, adapted to two opposite faces of the cube, in the manner already indicated. Having put the electric currents in motion, by plunging the projecting extremity of the four plates into salt water, the needle of the galvanometer deviated ten degrees. I suppressed the communication between the brass and the poles of the apparatus *à couronne de tasses*. I restored, as usual, the communication with the pair of lead and zinc with the fluid; the deviation was still the same.

Instead of the compound battery of the experiment which I have described, I substituted another, also twenty pairs, whose plates had a surface nearly quadruple. I repeated the experiment without changing the elementary battery, and I again obtained the same result.

I raised the compound battery to 100 pairs, and in another experiment to 200; and nevertheless, in causing the weak

current created by the zinc and lead, to be crossed by the powerful torrents of electricity, I could not change the effects of the last current upon the magnetic needle.

3. In order to put in opposition the electric currents of two compound batteries, I replaced the pair of lead and zinc by two other plates of brass, equal to those with which I had already armed the two other faces of the cube, and I put them in communication with the poles of a battery of ten pairs, while the first touched also one of the ends of the wire of the galvanometer, and the second was united to the other end of the same wire. I produced the circulation by the ordinary method. The needle deviated 14 degrees. I did not obtain a different effect, when having waited for a sufficient time till the apparatus had recovered its lost energy, I recommenced the experiment, after having caused to communicate the two plates of brass applied against the two other faces of the cube, with the poles of another apparatus *à couronne de tasses*, of ten, twenty, and even two hundred pairs.

4. Hitherto, I had always made the two currents which intersected each other circulate at the same time, from which perhaps arose the impossibility of proving the influence, either of an increased or of a diminished action upon the magnetic needle, exercised by one of the currents upon the other. For this reason I repeated the latter experiment, and the current of the apparatus of two hundred couples was not developed till after the needle of the galvanometer, put in motion by the apparatus of ten pairs, had become altogether immoveable; it then indicated a deviation of five degrees. But I thought it right to observe, with the greatest possible attention, the magnetic needle at the moment when the action due to the second apparatus manifested itself, and I did not perceive the slightest motion.

I repeated this experiment several times, by opposing in the manner above specified two currents produced by two batteries, which differed either by the surface of the plates, or by the number of the pairs, but always with the same result.

5. Convinced by the preceding experiments that the effect of an electric current was not at all altered when it passed through a liquid, which was traversed in a direction perpen-

dicular to its own by another electric current different from itself, I wished to ascertain if the same thing also happened when three electric currents intersected each other at right angles. With this view, I took a cube of hollow glass of 3 cent. on a side. I made a hole in the middle of each of its faces. I adapted to one of these holes a brass stopper left moveable, in order to be able to fill the cube with a liquid, and I shut each of the other holes with a small strip of brass fixed with Spanish wax. All these strips of brass, except the little stopper, were put in contact with as many small plates of lead, by means of several small pieces of brass. Having filled the cube with water, I put one of the strips of lead in communication with the positive pole of a battery *à couronne de tasses* of five pair, and the strip which went from the opposite face was put in communication with one of the ends of the wire of the galvanometer, while the other end communicated with the negative pole of the same battery, and the needle deviated fifteen degrees. Having suppressed this circulation, I put in communication with the extreme cups of a Voltaic apparatus of fifty couples, two other strips of lead, which were connected with the opposite faces of the cube, care being taken to leave the circuit broken for this purpose; and the strips connected with the two faces opposite to the cube were plunged into the extreme cups of another apparatus of fifty couples, in which the electric fluid had not been made to circulate. Every thing being prepared, I re-established the communication with the wire of the galvanometer in the apparatus of five couples; at the same time I produced the electric currents in the two other apparatus, and the needle deviated fifteen degrees as before.

In another experiment, instead of producing the three currents at once, I caused to circulate only that of the apparatus in communication with the wire of the galvanometer. I expected that the magnetic needle would cease to oscillate without breaking the circuit for that purpose; and when it became quiet, (the deviation was five degrees,) I established the electric circuit in the two other batteries; but the needle, without making the slightest motion, preserved its first position.

I did not find any difference in the results of other experiments, in which I had caused a current of an apparatus of

from five to twenty-five couples to traverse a liquid where two other currents, put in motion by the apparatus of 100 couples, intersected each other at right angles.

6. In order to force the electric currents to intersect one another under angles more or less acute in traversing a fluid, I procured a tube of glass 11 centimetres in length; the interior diameter was 1 cent.; one of its ends was closed by a plate of brass, and the other was supplied with a stopper of the same metal.

In the side of this tube, and in a direction parallel to its axis, three holes were made; the first was separated 2.7 cent. from the second, and the second from the third by the same distance. Exactly opposite to these, but on the other side, three other holes were made. We shall call the one set *Anterior*, to distinguish them from the others, which we shall denominate *Posterior*. All these holes were closed with small plates or rods of brass, to which, as well as to the stopper and the base of the tube were attached small pieces of lead, to establish, if required, the necessary communications with the poles of the batteries. The apparatus being thus arranged, I filled the tube with salt water; I made the anterior band which was nearest to the stopper communicate with the positive pole of a battery of twenty couples, and the posterior band nearest to the base with the end of a wire of the galvanometer. I put the other end in communication with the negative pole of the same battery: the needle deviated fifteen degrees. When the circuit was broken, and the needle ceased to oscillate, I restored the circulation at the same time that I caused the posterior band nearest to the stopper to communicate with the positive pole of another apparatus of twenty pairs, and the anterior band nearest to the base of the tube with the negative pole; the electro-magnetic effect was still the same.

7. I forced the current which run through the wire of the galvanometer to traverse in its full length the fluid contained in the tube, at the same time that the two other electric currents intersected each other in the same fluid under very acute angles, as had been done in the preceding experiment. The result was a deviation of twelve degrees; and such it was still, when I repeated this experiment, after having suspended the two currents which I have mentioned.

From these two experiments, which I have varied in several ways, we may conclude that the electric currents which intersect one another in a fluid at a very acute angle, do not weaken one another, and do not alter the effect of a third current which crosses it like themselves.

8. Causing the electricity which traversed the fluid from one extremity of the tube to the other, to pass through the wire of the galvanometer, I directed at the same time across the fluid three electric currents, in such a manner that they were all perpendicular to the direction which the current took which was to act on the magnetic needle; in this case the deviation was twelve degrees.

9. With this tube I wished also to try if the action of an electric current upon the magnetic needle was weakened when it passed through a liquid in which one or two other electric currents moved in a parallel direction to the first; but on account of the small space of fluid to be run over, and the distance of but 2.7 cent. which separated them, I did not consider these trials as sufficiently decisive. I then procured a hollow tube of glass of 5 cent. in the side; one of the faces had three holes furnished with common metallic bands, the distance between them being 1 cent.; three other holes disposed in the same manner were on the opposite face. Having filled the tube with water, I made the liquid be traversed with three electric currents in a parallel direction, and one of which acted upon the galvanometer. But whether the two other currents were equal to this last or different,—whether they were made to pass in the same direction as it, or in a contrary one,—the deviation of the needle was always equal to that which is obtained when the liquid is crossed only by the electricity which affects the magnetic needle.

In similar experiments we must take care that the electric currents of the Voltaic apparatus, not intended to act upon the galvanometer, do not find in the wet conductor which they ought to traverse, a passage more difficult than that presented to them by the battery intended to act upon the galvanometer; otherwise, a part of this electricity takes its course across the battery and consequently changes its effects.

10. After all, it may still be uncertain if the electric currents which cross the same conductor affect one another, or

rather if they act upon each other so as to modify their effects, only in the part where they run parallel across a given conductor, and not in the other parts of the same conductor. For this purpose I wished to try to make two or more electric currents pass through the same wire of a galvanometer. In order to do this, I fixed to one of the ends of the wire an oblong plate of lead dipping in a cup of water, and in another cup, I put a second similar plate, connected with the other end of the wire. A strip of lead which on one side communicated with the positive pole of a Voltaic apparatus of 28 pair, dipped in one of the cups, and in the other was placed the extremity of a second strip of the same metal, communicating with the negative pole of the same battery. The result was a deviation of 20 degrees. The circuit being broken without deranging, for this purpose, the plates of lead, I tried in a similar manner the effect of a second battery of 25 couples. I obtained a deviation of 25 degrees. I did not then suspend the circulation, and, when the needle had ceased to oscillate, the deviation was 6 degrees. In order to be certain that the battery of 25 pairs still produced the same effect, although the electricity of the apparatus of 50 pairs had already crossed the wire of the galvanometer, I turned the box of the galvanometer in such a manner that the needle still corresponded with the zero of the scale; I then restored the circuit in the apparatus of 25 pair, and the needle deviated exactly 20 degrees as before.

In this experiment, the two currents followed the wire of the galvanometer in the same direction. I had made them also pass through in a contrary direction; and the results presented no difference except in the species of deviation; it was now west instead of east.

Having caused the wire of the galvanometer to be passed through by electric currents of four batteries of five pairs each, that of twenty-five pairs again produced the same effect.

11. In all these experiments I have used the galvanometer as the instrument which would most easily show minute differences of electric effects. I have not, however, neglected the other effects produced by the battery, the tastes, the shocks, the electric tensions, &c. &c. but I could never perceive any difference between the effects obtained by an electric current

traversing a liquid, or where other currents circulated, and those created by the same current, while another electricity did not pass through the same conductor.

12. It is demonstrated by the preceding experiments, that the conductibility of liquids for electricity is not changed by the invasion of one, or many currents of electric fluid. We may perhaps find these facts more favourable to the theory of Franklin, than to that which considers electricity as composed of two fluids. (See note at the end.)

My wishes will be accomplished, if I have shown that when two or several electric currents traverse simultaneously a conductor crossing one another in any way, whether they are all in the same direction, or some in the opposite direction to others, and whether they are produced by equal or unequal batteries, one of these currents does not experience from the action of the rest any sensible alteration. In this fact we have, if I mistake not, a new and remarkable analogy between the propagation of electricity, and that of light.

Note by the Author.

In the examination which I have made of the causes which render galvanic apparatuses, constructed after the method of Novellani and Wollaston, more powerful than others, and which I have published in my essay on electrometric experiments, I have discovered a fact which is much better explained by the theory of Franklin than by that of two fluids. It is this. If, in a battery of 2 pair of plates, the electro-negative plate is more immersed in the fluid, the effect is greater than when it is the electro-positive plate which presents the largest wetted surface.

I may be permitted here to mention another fact which equally supports the theory of a single fluid.

Take a sheet of pewter, or any other metal, eighteen or twenty centimetres square, terminated on one side by a narrow band or tail; plunge this sheet in one glass of water, and let the tail be immersed in another. In the glass which holds the band, place another electro-positive plate, of zinc for instance, and in the other glass a similar plate, but electro-negative, for example of copper. (Neither of the plates should touch the

sheet.) Then join together by means of a galvanometer wire the plate of zinc with that of copper, and you will obtain a deviation of a few degrees. Plunge then the plate of copper in the glass which contains the tail or band, and the plate of zinc in the other glass, and the effect will be much more striking.

It would be in vain to endeavour to explain this fact by the help of the theory of two fluids, since if, on the one hand, when the plate of zinc is put into the glass which holds the band, the passage is difficult to the vitreous fluid; on the other hand, when the copper replaces the zinc, and the latter the copper, the passage is made difficult to the resinous electricity, and easy to the vitreous electricity. There is then no reason why the effects are different. But in admitting the theory of a single fluid, we know how, in the first case, the electric fluid which expands itself by radiation in the liquid finds the passage much more difficult than in the second instance; from which it appears, that the electro-magnetic effect, which, as is well known, principally depends upon the rapidity of the electric current, ought to be less in the first case, and greater in the second.—*(Ann. de Chimie.)*

ART IX.—*Account of an Excursion to the Diamond district in the governments of Bahia and Minas Gheraes in Brazil.* * By MM. MARTIUS and SPIX.

THE district of diamonds is a kind of sanctuary into which it is very difficult to penetrate. It is surrounded with a cordon of dragoons placed in picquets at from five to six miles from each other, who prohibit any person either from entering or leaving the district, without the special authority of the intendant-general of the province who resides at Tejuco. In quitting the district, every person, whether a native or a foreigner, is searched in the most rigorous manner. Not only are his baggage and his clothes rigorously examined, but his person, as well as his horse or his mules. The dragoons are also authorized to detain tra-

* From M. Spix and Martius's *Travels in Brazil, undertaken in* 1817—1820, *by order of the king of Bavaria, Maximilian Joseph I.* tom. ii. Munich, 1828.

vellers for twenty-four hours if they have reason to think that they have swallowed diamonds.

Having arrived at the *Villa do Principe*, about five miles from the frontiers of the diamond district, MM. Spix and Martius sent to Tejuco a government messenger, to request from the intendant-general the necessary passports, strengthening their request by the royal permission, with which they were favoured before quitting Rio Janeiro. As soon as they received them they set out, and in a few hours reached the object of their destination.

The town of San Antonio do Tejuco is situated in one of the most fertile and delightful districts of Brazil. It is the chief place of the district of diamonds, as well as the residence of the intendant-general of the *Junta diamantina*, composed of a procurator-fiscal of the crown, two treasurers, an inspector-general, and a book-keeper. A detachment of the regiment of dragoons of Minas who kept the garrison there, furnished the men necessary for guarding the frontiers and for executing the orders of the Junta. The population of the town is about 6000 souls.

Tejuco owes its prosperity to the working of the diamond mines. It was at the beginning of the eighteenth century that there were found in this district brilliant stones, to which at first no value was attached. An agent of the government, who had seen at Goa rough diamonds, first recognized the identity of these stones with the diamonds of India. Availing himself secretly of his discovery, he collected a great quantity of them, and returned with his treasure to Portugal, after having communicated his secret to one of his friends. The latter imparted it to the governor of Minas Gheraes; the government was made acquainted with the discovery; and in 1730 the government subjected the working of the diamond mines to a duty similar to that of the mines of gold. It was soon found that the collection of this tax was liable to insurmountable difficulties; and there was substituted in its place a capitation tax of from 20 to 30,000 reis (L. 5, to L. 7, 10s. Sterling,) for each slave employed in searching for diamonds. Ten years afterwards the limits of the diamond district were determined in a more positive manner, and the right of work-

ing them in all their extent, by employing 600 negroes, was farmed for four years by two Portuguese noblemen, Fernandez de Oliveira and Francisco da Silva, for the sum of 230,000 reis (about L. 63 Sterling) for each slave. This contract was renewed at different times, and the value of the farm rose by degrees to 450,000 crusados (about L. 56,250 Sterling.) The farmers took advantage of this augmentation, to work with a greater number of negroes than their contract allowed them, and the enormous profits which they made enabled them to establish a system of corruption, by means of which they assured themselves of impunity.

In 1772 the king resolved to regulate the working of the diamond mines. It was at this time that the district of Tejuco was transformed, so to speak, into a state within a state, and a royal administration was charged with the exclusive management of the working of the diamonds, from which individuals were prohibited. The Marquis de Pombal took upon himself the management of this establishment, and appointed three directors resident at Lisbon, three administrators resident in Brazil, and an intendant-general of the district of diamonds, invested with the most extensive powers. The direction of all the works necessary for the extraction of the diamonds, the administration of justice and that of police, were confided to the latter. He was authorized to banish from the district every inhabitant that was even under suspicion, and to confiscate all his property if a single diamond was found in his possession. Assisted by the diamond Junta, which was subordinate to it, this body determined without appeal all civil and criminal cases.

After the establishment of this new order of things, a census was taken of the inhabitants of the district. Every person who could not prove his origin was sent away, and if he tried to introduce himself clandestinely, he incurred for the first offence a fine and six months imprisonment; and in the event of repeating it, he was transported to the coast of Angola for the term of six years. Even the slaves were registered, and subjected to a severe surveillance. If a slave was discovered whose name was not enrolled in the register, the master to whom he belonged was condemned to transportation for three

years, and for a second offence for ten years. The same punishment was inflicted on the master whose slaves attempted to search for diamonds. All these laws, the object of which was to secure to the king the exclusive working of diamonds, subsisted at the time that MM. Spix and Martius visited the district of Tejuco.

It is in the gravel of the rivers that the diamonds are found; and the labour necessary for finding them is performed by slaves belonging to individuals, to whom the government pays weekly from two to four francs for each slave. As the places where they work are often far remote from any habitation, and in uncultivated districts, the slaves erect for themselves cabins of bulrushes, and the diamond *junta* provides them weekly with the necessary provisions. The number of slaves employed in this operation varies greatly. In 1775 it amounted to 5000. From that time it has constantly diminished; and in 1818 it was little more than 1000. In order to encourage the negroes to work, small entertainments were given them whenever they found a stone of any considerable size. Whoever found a diamond weighing above $17\frac{1}{2}$ quilots or carats, was purchased by the administration and set at liberty. If the value of the diamond was inferior to the price of the slave purchased, he was kept to work for the administration till he was completely liberated; and, on the contrary, if the value of the diamond exceeded his value, he received, with his liberty, a sum of money in addition.

The slaves are watched by *Feitores* or inspectors, who are, for the most part, whites, and whose duty it is to make the negroes work, to see that they deliver up the diamonds which they find, and to keep them from excess during their holidays. Other superior inspectors have a control over the *Feitores*, and receive the diamonds which are obtained, and which they put into a girdle fixed round their body, till they are carried to Tejuco. They direct also the necessary works for drawing from the rivers the *cascalhao*, or gravel which contains the diamonds.

In spite of all these precautions, there is a considerable contraband trade in diamonds. The diamond-searchers, called Grimpeiros, search in secret the gravel of the rivers and

brooks, at a distance from the royal establishments; and sometimes they carry their audacity so far, as to take them from the gravel accumulated near the *servicos*, or washing-places of the crown. These persons are commonly Maroon negroes, who have established themselves in the midst of rocks and inaccessible ravines. The slaves employed by the administration practise a thousand tricks to purloin the diamonds, and frequently succeed. In the very face of the inspectors, they know how to hide them between their toes, in their ears, in their mouth, among their hair, and sometimes they even swallow them. There are some negroes who make it their business to send out of the district the stolen diamonds, and in spite of the vigilance of the soldiers who guard the frontiers, these artful men, who know all the centinels, find means to make their way through them. At one time purchasers were readily found out of the district, who concealed the diamonds in bales of cotton or other merchandise, and forwarded them to their correspondents at Rio Janeiro or Bahia.

The following is the method of working for the diamonds. When a certain quantity of the gravel or cascalhao in which they occur has been taken out of the river and put up in heaps, a ditch about two feet is made, and water is brought into it. The negroes, whose business it is to examine the cascalhao, place themselves upon a bench placed in this ditch. Each slave has a wooden dish about fifteen inches in diameter, which he fills with cascalhao. He at first takes out of it the largest stones; he then plunges the dish into water, stirs it briskly, and removes from it all the gravel, till there remains only sand in the bottom. If he perceives in this sand a brilliant stone, he takes it between his thumb and inside finger, rises from his bench, and goes to deposit it in a small vessel filled with pure water, and placed on a stool before the inspectors. When he has finished his examination, he inverts his wooden dish, stretches out his arms and separates his fingers, to show that he has not kept any thing. He then goes again to fill his dish with cascalhao, and repeats the same operation. During all this time the inspectors, sitting opposite to the negroes at the distance of about twelve feet, keep their eyes on all their motions to prevent any fraud.

The inspectors remit every night the diamonds that have

been found to the administrators, who commonly live in the neighbourhood of the *servicos* or washing places. Once a week the latter carry the product of the washings to Tejuco, when the *Junta da Extracçao* examines, weighs, and registers them. They are divided into twelve classes or *lotes*, according to their weight and size. Those only are counted singly which belong to the three first classes, and which weigh at least three carats. With regard to the diamonds of the three other classes, they are satisfied with weighing them. Once a year the Junta assemble to inquire into the produce of each year; and after a proces-verbal has been drawn up, the diamonds are enclosed in a box with two locks, of which the intendant-general and the procurator-fiscal of the Crown have the keys. The box and the proces-verbal are then confided to a detachment of dragoons, to carry them to the governor of Villa Rica, who forwards them to Rio Janeiro.

The rivers which have always furnished the greatest number of diamonds, are the *Rio Jequetinhonha*, and the *Rio Pardo*. The first takes its rise in the *Serra do Gaviao*, to the south east of Tejuco, passes near this town, and afterwards takes a north west direction in crossing the great forests which extend along the coast, and falls into the sea near Porto-Seguro, after having taken the name of *Rio-Belmonte*. It is in the bed of this river that the greatest diamonds have been found. The *Rio Pardo* has its source near the west frontier of the district, runs in a north westerly direction, and discharges itself into the *Rio das Velhas*. Besides these two rivers, there is in the district of Tejuco a number of brooks which bring down diamonds; and, in order to extract them, their waters are often turned aside, in order to throw their diamonds dry.

It appears from official documents communicated to MM. Spix and Martius, that the weight of diamonds furnished by the district of Tejuco, from the year 1772, the time when the search for diamonds was put under proper regulations, till the year 1818, amounted to 1,298,073 carats. However great this produce may appear, it seems not to have been proportional to the expences of management; for a short time after the visit of our travellers to Tejuco, the government renounced the charge of it, and again made over to individuals the privilege of searching for diamonds.

ART. X.—*Notice of the performance of Steam-Engines in Cornwall for October, November, and December* 1829. By W. J. HENWOOD, F. G. S., Member of the Royal Geological Society of Cornwall. Communicated by the Author.

Reciprocating Engines drawing Water.

Mines.	Diameter of cylinder in inch.	Length of stroke in cylinder in feet.	Length of stroke in the pump in feet.	Load in lbs. per sq. in. of area of piston.	No. of strokes per minute.	Millions of lbs. weight lifted 1 foot high by the consumption of 1 bush. of coal.
Stray Park, -	64	7,75	5,25	7,8	5,	24,5
Huel Vor, -	63*	7,25	5,75	17,5	5,5	26,7
	53	9,	7,5	19,5	5,7	42,6
	48	7,	5,	8,	5,7	31,4
	80	10,	7,5	13,5	6,4	59,1
	45	6,75	5,5	13,7	7,	50,7
Poladras Downs,	70	10,	7,5	9,4	7,4	53,7
Huel Reeth,	36	7,5	7,5	15,3	4,	24,3
Balnoon, -	30	8,	7,	9,	3,3	23,2
Huel Towan, -	80	10,	8,	10,6	6,2	76,1
	80	10,	8,	6,7	4,3	64,9
United Hills, -	58	8,25	6,5	7,8	4,2	37,8
Crinis, -	56	6,75	6,75	9,	5,3	36,1
Huel Unity, -	52	6,666	5,75	9,1	7,1	30,
	60	7,25	5,75	13,8	5,8	33,3
Poldice, -	90	10,	7,	10,5	6,1	48,6
	60	9,5	6,25	12,8	5,6	38,3
Huel Damsel, -	42†	7,5	5,75	21,	4,9	34,7
	50	9,	7,	8,8	3,2	33,
Ting Tang, -	63	8,	6,	14,4	4,9	43,8
	66	9,	7,5	11,1	3,5	46,9
Cardrew Downs,	66	8,75	7,	10,4	6,3	53,
Huel Montague,	50	9,	7,	11,	3,9	29,
Dolcoath, -	76	9,	7,5	11,8	5,1	43,3
Great Work, -	60	9,	7,	10,2	7,7	44,2
Huel Penrose,	36	8,5	6,5	13,1	7,1	31,8
Huel Caroline,	30	7,	6,	23,4	9,1	30,
	53,5	8,333	7,	7,6	6,1	22,8

Mines.	Diameter of cylinder in inch.	Length of stroke in cylinder in feet.	Length of stroke in the pump in feet.	Load in lbs. per sq. in. of area of piston.	No. of strokes per minute.	Millions of lbs. weight lifted 1 foot high by the consumption of 1 bush. of coal.
St. Ives Consols,	36	7,	7,	15,7	6,5	29,6
Lelant Consols,	15	7,5	4,5	17,2	2,6	12,1
Binner Downs,	70	10,	7,5	10,9	8,2	62,7
	64	9,333	7,75	7,7	9,5	43,8
	42	9,	7,5	13,5	8,3	41,2
Consolidated Mines,	90	10,	7,5	8,8	5,2	59,3
	70	10,	7,5	9,7	5,9	61,4
	65	9,	7,5	15,4	3,9	56,6
	90	10,	7,5	8,4	7,1	61,
	90	10,	7,5	10,3	2,7	41,6
	6	9,	7,5	12,4	4,8	64,5
United Mines,	90	9,	8,	7,9	4,5	43,9
	30	9,	7,5	12,9	8,1	43,1
Huel Beauchamp,	36	7,75	6,	13,5	3,1	26,7
Huel Rose, -	60	9,	7,	14,	6,3	59,6
Pembroke, -	80	9,75	7,25	11,9	3,9	51,2
	50	9,	7,	11,2	7,2	45,3
East Crinnis, -	60	5,5	5,5	8,5	4,3	22,6
	70	10,	7,	9,4	4,9	36,7
East Huel Unity,	45	8,75	6,75	13,2	5,5	40,7
Huel Hope, -	60	9,	8,	12,	5,8	57,5
Huel Tolgus,	70	10,	7,5	8,2	5,3	54,3
Tresavean, -	60	9,	7,	6,7	4,2	21,3
Huel Falmouth,	58	8,75	6,5	4,3	5,5	26,5
Huel Sperris, -	70	10,333	7,75	6,7	6,6	44,3
Huel Prosper, -	53	7,	7,	3,9	5,6	23,8
Huel Leisure, -	36	9,25	6,75	14,3	7,8	35,4
	70	9,833	7,75	4,8	3,1	38,2

Average duty 41,4 millions of lbs. lifted one foot high by the consumption of one bushel of coal.

Watt's rotatory double engines employed to move machinery for bruising tin ores.

			Length of crank.			
Huel Vor,	24.	6.	3.	12.	15.	18.9
	27.	5.	2.5	12.	17.3	21.1
	16.5	5.	2.5	8.5	27.4	13.9

Average duty of rotatory engines, 17.97 millions.

* Watt's double engines.

† The steam, after passing through a high pressure, escapes into a Watt's single engine. All the other reciprocating engines are Watt's single.

ART. XI.—*Abstract of Meteorological Observations made in the Isle of Man, from* 1826 *to* 1829, *inclusive.* By ROBERT STEUART, Esq. Receiver-General of the Isle of Man. Communicated by Dr HIBBERT. *

A general state of the weather from January 1826 to December 1829. Thermometer (Fahrenheit) always out, on a northern exposure. Taken at 9 o'clock A. M., and at 11 o'clock P. M.

1826.

1826.	Medium of Thermom.		Wind, Number of Days.				Weather, Number of Days.			Rain Fallen.	
Months.	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow	Fair.	Inch.	100pt
January, -	39	35½	7	11	8	5	7	1	23	,,	79
February, -	44⅛	43	4	13	1	10	17	2	9	4	75
March, - -	43	44⅛	6	5	14	6	6	3	22	1	79
April, - -	48	43	11	4	2	13	10	1	19	2	59
May, - -	53	50	6	2	19	4	3	,,	28	,,	52
June, - -	60	55	11	9	7	3	3	,,	27	,,	4
July, - -	66½	63	6	11	4	10	10	,,	21	1	30
August, -	67½	62⅛	1	11	1	18	14	,,	17	2	35
September, -	58½	53	4	8	12	6	11	,,	19	2	4
October, -	55½	49⅛	8	5	4	14	17	,,	14	3	55
November, -	43½	42	10	,,	11	9	11	4	15	3	52
December, -	44½	44	8	7	4	12	17	1	13	6	28
General Medium.	53¼	49	82	86	87	110	126	12	227	29	52

	A. M.	P. M.
Highest state of Thermometer, -	75	70
Lowest, - - - - -	30	24

NOTE.—With reference to the "WIND," the *prevailing* point for the day is taken. If *any* rain, snow, or sleet, falls during the day, it is not considered as a fair day.

* A former series of Mr Steuart's observations, from 1822 to 1825, will be found in Vol. v. p. 231 of this Journal.

1827.

1827.	Medium of Thermom.		Wind, Number of Days.				Weather, Number of Days.			Rain Fallen.	
Months.	A. M.	P. M	N.	S.	E.	W.	Rain.	Snow	Fair.	Inch.	100pt
January, -	39	38	12	4	7	8	13	5	13	4	58
February, -	39	37	9	4	14	1	5	1	22	2	12
March, - -	42	41	9	2	2	18	15	5	11	5	65
April, - -	47	45	5	5	13	7	9	2	19	2	41
May, - -	52	49	4	17	7	3	14	,,	17	1	76
June, - -	57	53	8	12	6	4	11	,,	19	2	79
July, - -	60	55	11	8	8	4	10	,,	21	2	65
August, -	58	55	11	6	12	2	11	,,	20	4	58
September, -	59	55	5	12	10	3	12	,,	18	2	12
October, -	54	52	8	11	12	,,	15	,,	16	3	50
November, -	48	48	16	6	5	3	16	1	13	4	33
December, -	46	45	7	6	6	12	21	1	9	6	92
General Medium,	50	48	105	93	102	65	152	15	198	43	41

	A. M.	P. M.
Highest state of Thermometer, -	70	64
Lowest, - - - - -	29	25

1828.

1828.	Medium of Thermom.		Wind, Number of Days.				Weather, Number of Days.			Rain Fallen.	
Months.	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow	Fair.	Inch.	100pt
January, -	43	42	6	8	12	5	11	2	18	3	47
February, -	41	42	7	12	6	4	13	2	14	2	56
March, - -	41	43	14	5	6	6	7	3	21	1	80
April, - -	47	44	6	11	8	5	15	1	14	4	38
May, - -	54	51	3	3	17	8	10	,,	21	2	5
June, - -	58	55	2	10	8	10	10	,,	20	1	63
July, - -	58	59	,,	18	3	10	12	,,	9	3	33
August, -	61	58	4	8	11	8	9	,,	2	2	9
September, -	59	56	2	12	14	2	10	,,	0	2	50
October, -	53	51	6	10	7	8	14	,,	7	2	31
November, -	50	48	8	4	11	7	17	1	2	4	72
December, -	49	48	8	10	4	9	19	,,	12	5	6
General Medium,	51	49	64	113	107	82	147	9	210	35	90

	A. M.	P. M.
Highest state of Thermometer, -	67	64
Lowe[illegible] - - - - -	33	32

1829.

1829.	Medium of Thermom		Wind, Number of Days.				Weather, Number of Days.			Rain Fallen.	
Months.	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow	Fair	Inch.	100pt
January, -	36	41	12	2	17	,,	4	7	20	,,	87
February, -	43	43	6	2	12	8	9	1	18	1	58
March, - -	41	40	3	6	22	,,	4	,,	27	1	,,
April, - -	46	42	6	8	11	5	15	2	13	3	10
May, - -	53	50	4	15	7	5	5	,,	26	1	53
June, - -	60	54	8	8	6	8	11	,,	19	1	77
July, - -	60	55	9	15	4	3	18	,,	13	2	86
August, -	57	54	18	3	3	7	17	,,	14	5	80
September, -	52	49	13	8	2	7	17	,,	13	3	65
October, -	49	47	12	6	7	6	15	,,	16	6	10
November, -	44	45	6	4	8	12	14	1	15	3	81
December, -	40	39	5	14	11	1	6	2	23	1	82
General Medium,	48	46	102	91	110	62	135	13	217	33	89

	A. M.	P. M.
Highest state of Thermometer, -	65	62
Lowest, - - - - -	28	27

ART. XII.—*On Iso-geothermal Lines, or the distribution of the Mean Temperature of the Ground.* By M. KUPFFER of Casan.

IN the year 1819, when Dr Brewster was occupied with the inquiries respecting the mean temperature of the earth, of which he has published an account in the *Edinburgh Transactions*, vol. ix. p. 201, he was led to a very extensive comparison of the temperature of springs with that of the temperature of the air, and he concluded, from this comparison, "that there is a particular isothermal line, which in Europe is nearly that which passes through Berlin, at which the temperature of springs and that of the atmosphere coincide; that, as we approach the arctic circle, the temperature of springs is always higher than that of the air, while in approaching the equator it is always lower." Notwithstanding this curious difference, he found that the lines which represent the one are always parallel to the lines which represent the other, that is, to use the technical terms of Humboldt and Kupffer, *the Iso-*

thermal lines are always parallel to the Iso-geothermal ones. Hence the general formulæ which Dr Brewster has given for the points of the isothermal lines in all latitudes and meridians, are applicable to the points of the iso-geothermal lines by adding or subtracting a quantity depending on the distance of the place from the neutral isothermal line,—a quantity which can be determined only from a numerous series of observations.

In a valuable paper, of which we propose to give a short account, entitled, *On the Mean Temperature of the air and of the ground in some parts of Eastern Russia*, which was read to the Academy of St Petersburg on the 18th February 1829, M. Kupffer has projected the iso-geothermal lines as formed by the temperatures of springs in different places, and he concludes *that the iso-geothermal lines are far from coinciding with the isothermal lines.* This result stands in direct opposition to that obtained by Dr Brewster, and therefore requires some examination.

From the sketch of the iso-geothermal lines and the isothermal ones, as given by M. Kupffer, it is obvious that, as they approach to the Arctic regions, all approximation to parallelism disappears. But this arises from the imperfection of the isothermal projection as given by Humboldt, who was not possessed of sufficiently numerous observations to give them more correctly. In the formulæ of Dr Brewster, verified by the accurate observations of Sir Charles Giesecke in Greenland, and of Mr Scoresby in the Arctic Seas, and still more strikingly confirmed by the subsequent observations made in the voyages of Sir Edward Parry and Sir John Franklin, the isothermal lines in Europe and America quit one another entirely and surround two cold poles, one in America and another in the North of Asia. Now it is a most remarkable fact, that the American and European portions of M. Kupffer's iso-geothermal line of 0° Reaumur, actually separate, and are clearly going round the two poles of maximum cold. This valuable result not only removes every difficulty respecting the apparent want of parallelism of the two classes of lines in the Arctic region, but it affords an independent proof of the general correctness

of the formulæ of Dr Brewster, which necessarily carry the isothermal lines round two separate poles.

The following is the general table given by M. Kupffer. We have not converted the degrees of Reaumur into those of Fahrenheit, because it is the comparison of the two columns with which we are principally concerned.

Places.	Latitude.	Height in metres.	Temperatures observed on Reaumur's scale. Of the ground.	Of the air.	Observers.
Congo,	9°. S.	450	+ 18°.2	+ 20°.5	Smith
Cumana,	10 .15 N.		20 .5	22 .4	Humboldt
St Jago C. Verd,	15		19 .6	20 .0	Hamilton
Rockford Jamaica,	18		20 .9	21 .6	Hunter
Havannah,	23		18 .8	20 .5	Ferrer
Nepaul,	28		18 .6	20 .0	Hamilton
Teneriffe, *	28 .30		14 .4	17 .3	Buch
Cairo,	30		18 .0	18 .0	Nouet
Cincinnati,	39	160	9 .9	9 .7	Mansfield
Philadelphia,	40		10 .2	9 .9	Warden
Carmeaux,	43	300	10 .4	11 .5	Cordier
Geneva,	46	350	9 .9	7 .7	Saussure
Paris,	49	75	9 .2	8 .7	Bouvard
Berlin,	52 .30	40	8 .1	6 .4	
Dublin,	53		7 .7	7 .6	Kirwan
Kendal,	54		7 .0	6 .3	Dalton
Keswick,	54 .30		7 .4	7 .1	
Konigsberg,	54 .30		6 .5	5 .0	Erman
Kisnekejewa,	54 .30	300	3 .5	— 1 .2	Kupffer
Kasan,	56	30	5	2 .4	Id.
Edinburgh,	56		7	7 .0	Playfair
Carlscrona,	56 .15		6 .8	6 .8	Wahlenberg
Nishney-Tagilsk,	58	200	2 .3	0 .2	Kupffer
Werchoturia,	59	200	1 .9	0 .7	Id.
Bogoslowsk,	60	200	1 .5	1 .2	Id.
Upsal,	60		5 .2	+ 4 .5	Wahlenberg
Umeo,	64		2 .3	0 .6	Id.
Giwarten-Fiall,	66	500	1 .0	— 3 .0	Id.

It is evident, from this table, says our author, that under the same parallel the temperature of the ground varies according to the meridians, and that in order to have a just idea of the progress of this temperature, we must compare places situated under the same meridians. The above observations may

* This is also the temperature of springs at the height of 1500 feet, so that the low springs must have their origin at a great height.

therefore be arranged under four meridional zones, depending on the meridians of Paris, Umeo, Ural, and Cumana.

Besides, among the stations on the table, there are several at a very considerable height above the sea, so that we must reduce their geothermal temperature to the level of the sea. Unfortunately we possess so few observations of this kind, that it is impossible to determine with accuracy the diminution in the temperature of the ground which corresponds with a given elevation. Our author, however, concludes, that the decrease in the temperatures of springs follows the same law as that of the atmosphere, or, if there is a difference, that it is less rapid in the former than in the latter case. He therefore uses 1° of Reaumur for every 250 metres. By applying this correction, and distributing the places into zones, he obtains the following tables.

First Meridian of 0°

	Latitude.	Temperature of ground.
St Jago,	15° 0′ N.	+ 19°.6
Teneriffe,	28 30	14 .4
Carmeaux,	43	11 .6
Geneva,	46	10 .3
Paris,	49	9 .5
Dublin,	53	7 .7
Keswick,	54 30	7 .4
Edinburgh,	56	7 .0

Second Meridian of 20° *East.*

Cairo,	30° N.	+ 18°.0
Carlscrona,	56 15	6 .8
Upsal,	60	5 .2
Umeo,	64	2 .3
Giwarten-Fiall,	66	3 .0
Congo,	9 S.	20 .0

Third Meridian of 60° *East.*

Kisnekejewa,	54° 30′	4°.7
Nishney-Tagilsk,	58	3 1
Were[illegible]in,	59	2 7
Bog[illegible]	60	2 .3

Fourth Meridian of 80° *West.*

	Latitude.	Temperature of ground.
Cumana,	10°	20.5
Rockford,	18	20.9
Havannah,	23	18.8
Cincinnati,	39	10.5
Philadelphia,	40	10.2

From these tables M. Kupffer draws the following conclusions:—

1. The temperature of the air, and the mean temperature of the ground, are not the same under the same parallel. If we make the lines pass through those points where the temperature of the ground is the same, those lines which may be called *Iso-geothermal*, have been hitherto synonymous with the isothermal lines.

2. The temperature of the ground, as well as that of the air, decreases as the latitude increases. This decrease is more rapid as we approach the parallel of 45°, and at greater latitudes it decreases more slowly. This circumstance explains why in low latitudes the temperature of the ground is inferior to that of the air. For the same reason in mean latitudes the temperature of the ground reaches that of the air, and rises above it in higher latitudes.

3. M. Kupffer states, that we may represent the relation between the latitude and the temperature of the ground, by the formula, $a—b$, Sin.^{2} $l = t$, in which l is the latitude, t the corresponding temperature, and a and b constant quantities to be determined for each meridian. Having determined these coefficients, he finds, that the observed and calculated temperatures agree pretty well, except for Cumana, Teneriffe, Konigsberg, and Umeo, places upon which local circumstances appear to impress an anomalous character.

It must not be forgotten that this formula gives only approximations, and that it may give false results for points too remote from those where the observations have been made. Among these points are the poles, for which the four equations ought to give the same value, which is not the case. It

may be presumed, that the minima of the temperature of the ground meet in the neighbourhood of the pole, but this is what the formula cannot indicate, since it gives the greatest value of t when $l = o$, and the smallest when $l = 90°$.

The iso-geothermal line of 0°, approaching greatly to the north pole under the first meridian, and even reaching it,—if we admit the result of the formula in this case, it follows, that the space terminated by this line is marked in this place with a great break, *and appears to separate into two portions, of which the central points may be considered as two poles of cold for the ground. One of these poles will probably be in North America, and the other in the North of Siberia.* Unfortunately observations are wanting for these regions. The temperature of these poles cannot be much below 0°.

With regard to the temperature of the ground under the equator, it is obviously lower at points situated on the coast, or in the islands, than at those which are in the interior of a great continent. The warmest part is in the interior of Africa. To the north of this point, at least in latitudes which do not exceed 50°, the iso-geothermal lines take a great bend to the north. The point of the equator situated at 60° of longitude, has a lower temperature by $1°\frac{1}{2}$. We find nearly the same depression for the nearest points of Teneriffe and Cumana. It may hence be presumed, that the coldest point of the equator is between 60 and 80° of west longitude in the Atlantic Ocean. Setting out from this point, the temperature of the ground increases rapidly from east to west. It may be said of the equator, as of the poles, that the formula is not applicable to it.

With regard to the more elevated temperatures of the ground which are observed in the latitudes of the second meridian, we have only conjectures to propose. The phenomenon may be explained in the vicinity of the equator, by the heat of the sandy deserts; but this cause could have no influence under higher latitudes. We may perhaps seek for it in the volcanic condition of the earth under this meridian. We there find, indeed, two active volcanoes, Vesuvius and Ætna. Germany is covered with basaltic and other volcanic formations. A multitude of springs, more or less warm, attest the high tem-

perature of the interior of the earth. The Tyrolese Alps present every where porphyry and pyroxene, of which their masses are composed. To the south of the equator we have, under the second meridian, only one observation, that of Congo; and, if we may be permitted to draw a conclusion, it indicates that the warmest iso-geothermal line does not coincide with the terrestrial equator. To find a point in the former, we may take the middle of the distance which separates the line at 20°, and the station of Congo, where 22° is the temperature of the ground. If, as may be presumed, this equator runs parallel to the line of 20°, its temperature under the first meridian is greater than that which has been calculated for the ground of the terrestrial equator. It is smaller under the 2d, 3d, and 4th. The temperature of the iso-geothermal equator will be more equal than if this line connected with the terrestrial equator, and will nowhere deviate greatly from 22°, the mean temperature of these regions."

M. Kupffer next proceeds to show that his system of Isothermal lines accords with some of the leading facts of physical geography, such as the progress of vegetation in different places, that of the polar ices, and the distribution of terrestrial magnetism.

"The temperature of the ground," says he, "is connected by different relations with the other great phenomena of our globe. Wahlenberg has already remarked, that the existence in high latitudes of durable vegetables with deep roots, such as trees and shrubs, can arise only from the temperature of the ground exceeding that of the air. In these latitudes the periods of vegetation appear to follow that of the temperature of the ground almost as much as that of the air. This is an observation which I have often made in my excursion to the north of the Uralian Chain. In middle Russia vegetation commences later than in Germany, but the harvest takes place nearly at the same time, viz. in July. Farther to the north, till the mean temperature is 0° (32° Fahr.) the harvest is later, viz. in August, or even in the beginning of September. This epoch, which coincides with the maximum of temperature in the air, is connected also in high latitudes with that of the temperature of the ground.

The relation which appears to exist between the more northern iso-geothermal lines and the limit of the polar ices deserves also to fix our attention. The line of 0° (32° Fahr.) is a little to the south of the limits of the ice, excepting towards Greenland; but we know that this country was not formerly surrounded with ice as it is at present. Besides, the temperature of the ground can only act upon masses of ice which descend to a certain depth; but those which are found in the *terra firma* cannot be in this predicament, and it becomes easy to explain in this way the influence of a continent such as Greenland, on the limits of the polar ices. The removal of the ice to the south west, which Mr Scoresby has so well observed on the east coast of Greenland, *demonstrates the existence of poles of cold in the North of America, and particularly in Greenland;* at least I do not know how we can otherwise explain a phenomenon so contrary to our ordinary ideas of the distribution of temperature on the surface of the globe. It is evident that if the coldest point of the polar sea coincided with the pole, the coldest waters would form in the depths of the sea a current from north to south, while the warmest would transport themselves to the surface from south to north. Modified by the rotation of the earth, the first of these currents would take a south-west direction, and the second a north-east direction, and as it is the superficial waters which transport the icebergs, this transport ought to take place in a north-west direction in place of the very opposite direction which it actually takes. But if the coldest point of this region is at some distance from the pole, the surface current ought to direct itself to the south, or rather to the south-west, on account of the earth's rotation. We shall yet find, I think, a close relation between the phenomenon of currents in the sea, and the distribution of the temperature of the ground.

But this distribution of temperature *appears also to have a great influence on the distribution of the intensity of terrestrial magnetism.* This would no doubt be the case, if it is true, as I have tried to show in another memoir, that terrestrial magnetism resides at the surface of the globe. We have here the choice between two hypotheses; either the earth should be considered [illegible]net existing by itself, and then the inten-

sity of its magnetism will be the inverse of its temperature; or it receives its influence from without, and is only like a piece of soft iron to which the presence of a distant body communicates magnetism, and then the intensity of its magnetism will increase with its temperature. Though the first of these hypotheses has been hitherto generally adopted, yet the second acquires some probability by the discovery of the magnetic influence of the solar rays, (See this No. page 225,) and of the known relation between the diurnal variations of the declination of the needle, and the course of the sun.

If we consider the globe as a warm mass highly susceptible of magnetism, whose surface has an almost uniform temperature, and which is rendered magnetic by the action of a distant celestial body, it is evident that its magnetism will be distributed in a manner perfectly regular, and that the lines of equal inclination will coincide with those of equal intensity. But if the surface becomes by degrees unequally heated, the lines of equal intensity will be modified, and will in some points separate from the lines of equal inclination. If one of these last lines passes through several points in which the temperature of the ground is the same, the intensity of magnetism in these different points will also be the same; but in all points where the temperature of the ground is higher or lower, the intensity, according to our hypothesis, will be stronger or weaker. This indeed appears to be the case, and if future observations agree with those already made, we may regard this circumstance as a powerful demonstration of the hypothesis in question.

In the magnetic chart of Hansteen, drawn in 1825, we see that the lines of equal inclination and equal intensity are sensibly parallel in Scotland, but that farther east, in Norway and in Sweden, they both bend towards the north and cut the first. Besides, on the same line of equal inclination, the intensity is weaker to the east than to the west, and it is the same with the temperature of the ground. Thus, for example, the inclination is nearly the same at Edinburgh and at Stockholm. But in the first of these towns the intensity is as 1.400, and the temperature of the ground 7°, whilst in the second the intensity is as 1.386, and the temperature of the

ground is as 5°.2. It is the same at Paris and Kasan, where the inclination differs little. At Paris the intensity is 1.348, and the temperature of the ground 9°.2, and at Kasan the one is 1.320 and the other 5°. At Teneriffe the intensity is 1.298, and the temperature $14\frac{1}{2}°$, whilst at Naples the one is 1.275 and the other 13°.

We may hence easily understand why the pole of intensity is to the south of the pole of inclination. As the temperature of the ground goes on diminishing to the north, the lines of equal inclination nearest the pole of inclination pass through colder points to the north of this pole than to the south; but in these colder points, the intensity, according to the principles above laid down, ought to be weaker than in the others. We ought, therefore, to seek for the pole of intensity, that is, the point where the magnetic intensity is a maximum to the south of the pole of inclination; and it is actually there where it is found by the calculation of the last observations of Mr Hansteen. The pole of inclination is in 71° lat. and 102° long.; that of intensity is in 56° of lat. and 80° of long. west of Paris.

Such is a very imperfect account of M. Kupffer's memoir, as we find it in an abstract in the *Bibl. Universelle*, where the formula, with the numerical values of *a* and *b*, are unaccountably omitted.

It is obvious that M. Kupffer has not seen Dr Brewster's paper on the mean temperature of the earth, where the same results nearly, respecting the isothermal equator, are deduced, which M. Kupffer deduces for the iso-geothermal equator. The whole of M. Kupffer's valuable results present the most striking confirmation of the isothermal law of Dr Brewster, communicated nearly ten years ago to the Royal Society of Edinburgh, that the distribution of temperature on the earth's surface is related to four poles of maximum cold, two to the north, and two to the south of the equator, and nearly related in position to the magnetic poles of the earth.

We expect to be able in an early Number to give an abstract of Dr Brewster's paper, accompanied with a map of the isothermal lines surrounding the two poles of maximum cold in the northe[illegible]e.

Art. XIII.—*Contributions to Physical Geography.*

1. *Account of the Discovery of Diamonds in Russia.* In a Letter from St Petersburgh.

It is not many years since the produce of the Russian gold mines amounted to only forty pud * at the utmost. This quantity was raised, with great expence and severe toil, from deep pits. Who would not have smiled then at the assertion, that after a short time, on an immense tract of soil, the richest gold beds,—that masses of solid gold and platina would be found, in quantities so great, as have hitherto not been found in the new world. And yet this has happened. Russia is, in this respect, not behind the countries of the other hemisphere, which, from the discovery of America, were in some degree the monopolizers of the precious metal. Russia has been the first to coin money from platina; yet these countries had an advantage over her in the possession of the invaluable diamond. This she also now has; the first Russian diamond was found on the 22d June 1829, on the western side of the Ural, at the Biszer gold-wash of Countess Polier, by a boy thirteen years of age, of the name of Pawel Popow.

The first well-grounded hint of the probable existence of diamonds in Russia, is due to the Professor of the University of Dorpat, Maurice Engelhardt, who, on a scientific journey which he made in the Ural in the year 1826, wrote from thence about this remarkable object to the rector of the university, State Councillor Ewers. In an extract of this letter, which was printed at the time (1826) in the *Journal de St Petersbourg*, No. 118, it is said, among other things—"La sable de platine de Nijny-Toura appartenant à la fabrique de la couronne Koushra, offre une resemblance frappante avec celui du Brèzil, où l'on trouve ordinairement les diamans. D'après la description de M. d'Esckwege (Geognostisches Gemalde Von Brasilien, Weymar, 1822,) celui ci est composé principalement de galets d'un hydrate de fer (le Brauneisenstein des Allemands,) et de jaspe, et offre en outre une multitude de petites pierres microscopiques de diverses couleurs et plus de platinè

* About 1500lb. avoirdupois.

que d'or. Le sable des mines de Nijny-Toura offre le même mèlange, et la prèsence de l'hydrate de fer est l'autant plus remarquable, que c'est dans cette brèche qu'au Brézil on trouve le diamant incrusté; ce qui fait voir que ces deux minéraux ne se trouvent pas par hazard ensemble, mais comme debris d'une même formation de roches."

As the above-mentioned sand strata (sables) extend for more than 250 square wersts, and are for the most part covered with wood, M. Von Engelhardt could not enter into any particular researches for diamonds, which, probably mingled with a quantity of other little crystals, could not otherwise be separated from the clayey sand, than by the operation of washing, and where, besides, all depended upon a happy accident of the finder. But he communicated his remarks, and the opinion, that doubtless diamonds were to be found here, to the directors of the Turinsky works, who were ready to make the necessary preparations for the discovery of the treasure, hidden in the lap of the earth. At the same time he advised them, as the external quality of rough diamonds would probably be little or not at all known to the officers there, to send some from St Petersburgh, to serve as specimens at their searchings.

The St Petersburgh Scientific Committee for the mines ordered the letter of Professor Engelhardt to be printed in a Russian translation, in the 11th number of the *Journal for Mining Science*. In the following year, by order of the Finance Minister, an order was sent to all mine-directors at the Ural mountains, and also to the Perm mine administration, to make a search for diamonds. Also, in the year 1829, the director of the Bogaszlowsky mines sent out a peculiar expedition to make such researches, which indeed did not discover diamonds, but one of the richest beds of gold sand.

In September of this year, finally, the finance minister got a report by Count Polier, then residing at the estates of his lady, situated at the Ural, stating, that Baron Humboldt, on his journey through those parts, had several times found the most striking resemblance between the Ural and Brazilian mountains, and after manifold observations and inquiries was persuaded th Ural must contain diamonds. This opi-

nion of so celebrated and experienced a natural historian excited double attention to this object in all gold washers visited by him. The washed sand was examined with microscopes, in the hope that these precious crystals might be discovered therein. However, during the presence of Baron Humboldt, not a trace of them was found on the whole eastern side of the mountain.

When Baron Humboldt proceeded on his journey, Count Polier separated from him, and repaired to the possessions of his lady, situated at the western side of the Ural, where he visited, on the 23d of June, a gold-wash situated at twenty-five wersts from the Biszer manufactory. Here, in consequence of an order before given, several specimens of gold and platina sand, and of several quartz crystals found therein, were laid before him, among which he discovered the first Ural diamond. The crystal, a day before the arrival of the Count, had attracted the attention of a peasant boy, of thirteen years, of the name of Pawel Popow, at the wash of the gold-sand; and, as a reward is offered for the discovery of uncommon or remarkable minerals, he had delivered it to the inspector, who, however, did not see in it any thing extraordinary, and cast it therefore among the other crystal specimens. Three days after another boy found one, and finally a third one, the whole weight of which was superior to that of the two former taken together. Afterwards, according to the notices of Count Polier, in the same gold-wash there have been found several diamonds, which, according to the judgment of connoisseurs, are in no respect behind the Brazilian ones.

It cannot be doubted that by this success all the rest of the gold-washers will be excited to make a search for diamonds their particular business, and that thereby a new source of riches will be opened to Russia, in which many unknown treasures lie yet concealed.—*From the London Packet.*

2. *Account of Caverns in the Empire of Tungkin.*

In several parts of Tungkin, but particularly in the province of Xu-than, there are within the mountains many caverns, some of which are known only to the neighbouring vil-

lagers, who conceal their effects in them during the time of war. Some of them are used as temples for their sacrifices. The existence of others, their beauties and singularities, are secrets which are never revealed, lest the Emperor or some great mandarin should have the curiosity to visit them, for such visits are always very expensive to the people among whom they are made. A naturalist would find in these caverns a vast field for observation. They are all filled with petrifactions and crystallizations which have various colours, and with other remarkable singularities.

One of the most remarkable of these caverns is a quarter of a league long. It traverses a mountain from one end to the other, and opens at both ends into fertile and well cultivated plains. The whole of the bottom of the cavern is filled with pure water from six to eight feet deep. It is easily navigated, but for this purpose the traveller must be furnished with torches. The roof appears to be formed of stones of the nature of chalk. In some parts the roof is only from eight to ten feet above the water, while in others it rises to a very great height.

Near this cavern there is another, whose entrance is more surprising, and its interior elevation much higher. It contains no water. Sometimes the roof is narrow, and sometimes it widens, and forms immense chambers, containing natural tables, altars, thrones, and moveables of every kind. These wonders are all celebrated by the Tungkinese poets.

In the same chain of mountains, and in the canton called the Great Desert, about twenty leagues from the above cavern, there is a cavern of immense size, and the largest in the country. It contains a fetid air, and its exhalations are insalubrious. It can only be reached by sailing along a canal, the waters of which cannot be drunk without danger. The canal itself makes a number of turns, and at every turn it is necessary to place a torch in order to find one's way out of it. Nobody has yet ventured far into the cave. Its extremity has never been reached, and it is unknown whether or not there is any other entrance to it.—*Exposé Statistique du Tunkin*, sur la relation de M. De la Bissachese, p. 40–43.

3. *Account of the Mirage of Central India.*

It is only in the cold season that the *mirage* is visible; the sojourners of Maroo call it the *see-kote*, "or castles in the air." In the deep desert to the westward, the herdsman and travellers through these regions style it *chittrám*, "the picture;" while about the plains of the Chumbul and Jumna they term it *dessasúr*, "the omen of the quarter." This optical deception has been noticed from the remotest times. The prophet Isaiah alludes to it, when he says, "and the parched ground shall become a pool," which the critic has justly rendered, 'and the *sehráb* shall become real water." Quintus Curtius, describing the *mirage* in the Sogdian desert, says, that "for the space of four hundred furlongs not a drop of water is to be found, and the sun's heat, being very vehement in summer, kindles such a fire in the sands, that every thing is burnt up. There also arises such an exhalation, that the plains wear the appearance of a vast and deep sea;" which is an exact description of the *chittrám* of the Indian desert. But the *sehrab* and *chittrám*, the true *mirage* of Isaiah, differ from that illusion called the *see-kote;* and though the traveller will hasten to it, in order to obtain a night's lodging, I do not think he would expect to slake his thirst there.

When we witnessed this phenomenon at first, the eye was attracted by a lofty opaque wall of lurid smoke, which seemed to be bounded by, or to rise from, the very verge of the horizon. By slow degrees, the dense mass became more transparent, and assumed a reflecting or refracting power: shrubs were magnified into trees; the dwarf *khyre* appeared ten times larger than the gigantic *amli* of the forest. A ray of light suddenly broke the line of continuity of this yet smoky barrier; and, as if touched by the enchanter's wand, castles, towers, and trees, were seen in an aggregated cluster, partly obscured by magnificent foliage. Every accession of light produced a change in the *chittrám*, which from the dense wall that it first exhibited, had now faded into a thin transparent film, broken into a thousand masses, each mass being a huge lens; until at length the too vivid power of the sun dissolved the vision: castles, towers, and foliage, melted, like the enchantment of Prospero, into "thin air."

I had long imagined that the nature of the soil had some effect in producing this illusory phenomenon; especially as the *chittrám* of the desert is seen chiefly on those extensive plains productive of the *saji*, or alkaline plant, whence by incineration the natives produce soda, and whose base is now known to be metallic. But I have since observed it on every kind of soil. That these lands, covered with saline incrustations, tend to increase the effect of the illusion, may be concluded. But the difference between the *sehrab* or *chittrám*, and the *see-kote* or *dessasúr*, is, that the latter is never visible but in the cold season, when the gross vapours cannot rise; and that the rarefication, which gives existence to the other, destroys this, whenever the sun has attained 20° of elevation. A high wind is alike adverse to the phenomenon, and it will mostly be observed that it covets shelter, and its general appearance is a long line, which is sure to be sustained by some height, such as a grove or village, as if it required support. The first time I observed it was in the Jeipoor country; none of the party had ever witnessed it in the British provinces. It appeared like an immense walled town with bastions, nor could we give credit to our guides when they talked of the *see-kote*, and assured us that the objects were merely "castles in the air." I have since seen, though but once, this panoramic scene in motion, and nothing can be imagined more beautiful.

It was at Kotah, just as the sun rose, whilst walking on the terraced roof of the garden-house, my residence. As I looked towards the low range which bounds the sight to the south-east, the hills appeared in motion, sweeping with an undulating or rotatory movement along the horizon. Trees and buildings were magnified, and all seemed a kind of enchantment. Some minutes elapsed before I could account for this wonder; until I determined that it must be the masses of a floating *mirage*, which had attained its most attenuated form, and being carried by a gentle current of air past the tops and sides of the hills, while it was itself imperceptible, made them appear in motion.

But although this was novel and pleasing, it wanted the splendour of [illegible] of the morning, which I never saw

equalled but once. This occurred at Hissar, on the terrace of James Lumsdaine's house, built amidst the ruins of the castle of Feroz, in the centre of one extended waste, where the lion was the sole inhabitant, that I saw the most perfect specimen of this phenomenon: it was really sublime. Let the reader fancy himself in the midst of a desert plain, with nothing to impede the wide scope of vision, his horizon bounded by a lofty black wall encompassing him on all sides. Let him watch the first sunbeam break upon this barrier, and at once, as by a touch of magic, shiver it into a thousand fantastic forms, leaving a splintered pinnacle in one place, a tower in another, an arch in a third; these in turn undergoing more than kaleidoscopic changes, until the "fairy fabric" vanishes. Here it was emphatically called *Hurchund Raja ca poori*, or, "the city of Raja Hurchund," a celebrated prince of the brazen age of India. The power of reflection shown by this phenomenon cannot be better described than by stating, that it brought the very ancient *Aggaroa*, which is thirteen miles distant, with its fort and bastions, close to my view.

The difference then between the *mirage* and the *see-kote* is, that the former exhibits a horizontal, the latter a columnar or vertical stratification; and in the latter case, likewise, a contrast to the other, its maximum of translucency is the last stage of its existence. In this stage, it is only an eye accustomed to the phenomenon that can perceive it at all. I have passed over the plains of Meerut with a friend who had been thirty years in India, and he did not observe a *see-kote* then before our eyes: in fact, so complete was the illusion, that we only saw the town and fort considerably nearer. Monge gives a philosophical account of this phenomenon in Napoleon's campaign in Egypt; and Dr Clark perfectly describes it in his journey to Rosetta, when "domes, turrets, and groves, were seen reflected on the glowing surface of the plain, which appeared like a vast lake extending itself between the city and travellers." It is on reviewing this account, that a critic has corrected the erroneous translation of the Septuagint; and further dilated upon it in a review of Lichtenstein's travels in Southern Africa, who exactly describes our *see-kote*, of the magnifying and reflecting powers of which he gives a singular

instance. Indeed, whoever notices, while at sea, the atmospheric phenomena of these southern latitudes, will be struck by the deformity of objects as they pass through this medium: what the sailors term a fog-bank, is the first stage of our *seekote*. I observed it on my voyage home; but more especially in my passage out. About six o'clock on a dark evening, while we were dancing on the waste, I perceived a ship bearing down with full sail upon us so distinctly, that I gave the alarm in expectation of a collision; so far as I recollect, the helm was instantly up, and in a second no ship was to be seen. The laugh was against me—I had seen the "flying Dutchman," according to the opinion of the experienced officer on deck; and I believed it was really a vision of the mind; but I now feel convinced it was either the reflection of our own ship in a passing cloud of this vapour, or a more distant object therein refracted. But enough of this subject: I will only add, whoever has a desire to see one of the grandest phenomena in nature, let him repair to the plains of Mairta or Hissar, and watch before the sun rises the fairy palace of Hurchunda, infinitely grander and more imposing than a sunrise upon the alpine Helvetia, which alone may compete with the *chittrám* of the desert.—*Col. Tod's Rajast'han.*

4. *A farther Account of the Cave of Booban.**

Having already laid before our readers an account of this remarkable cave, we shall now give an account of a recent visit to it made by Mr Walters in December 1828.

Leaving Sylhet on the 8th, he reached the mouth of the cave about noon next day. The mouth of this cavern is in the side of the great limestone mountains, and faces the south-west. The entrance hardly attracts notice, and few would suppose that such a small hole is the portal to such magnificent chambers. One person only can enter at a time. "On entering the cave we descended about thirty yards over large broken pieces of rock, some of them difficult to climb over, and reached a level. After preparing our torches, and getting every thing in order, we followed our Cosseah guide, and leaving a large cavern unexplored on the left, took a pas-

* See t[illegible] xv. p. 54, and No. xvii. p. 51-54.

sage on the right. The roof formed a perfect natural arch, one side more perpendicular than the other, and the whole was encrusted with stalactites. We proceeded on in a west and north-west direction: sometimes the passage was narrow and the roof low, then swelled into superb chambers, the roof forty feet high. In some places we walked along perfectly smooth rock, in others over soft mud, and in others again, climbed over broken but huge fragments of rock. Here and there we came upon water in rocky basins, and in many parts the rock was honey-combed by the action of the dropping water. The variety and beauty of the shapes into which the stalactite has formed itself exceed description. In one place was a remarkable specimen like a pine tree, about twelve feet high, by one foot and a-half thick, except here and there; however, it did not sparkle to the light, as I had expected, being covered with brown dirty coating, though in particular spots it was very beautiful. After wandering through numerous narrow passages and various splendid halls, sometimes descending fifty feet, and sometimes ascending to a greater height, we were at last stopped by a deep basin of water. Here, as it was getting late, we turned, and following another passage, found ourselves in our former track again. We had tied a string to the rock at the cave's mouth, and let it run off a reel as we advanced, and three balls had already been expended. There we joined the two strings, and some of us remained, while others, retracing their steps to meet some of the people with oil-pots, who could not descend a precipice, rejoined us again at the same spot. Numerous passages were left to the right and left, and several singular fissures were apparent in the rock at different elevations. The mountain appears to be perforated in all directions, like a honey-comb. In one place daylight is visible through the roof at a great height. We now retraced our steps to the mouth of the cave, which we reached at three o'clock. The thermometer outside the cave stood at 68°, in the shade of the trees with which the entrance is surrounded; inside it rose to 74°. The air, however, was not close or disagreeable; indeed a free circulation evidently takes place. I was, on the whole, much pleased and gratified by the excursion. The cave is certainly a wonderful natural

curiosity, and much resembles the drawings of the famous cave of Antiparos in the Levant. Its full extent has not yet been ascertained: tradition says it joins the subterranean passages of the seraglio of Pekin! We paced the distance, and took bearings, and found we had gone nearly a mile before we turned. An abrupt and deep precipice obstructs the road a little beyond where we turned, and farther than this has not yet been explored. It would be curious to follow it up, and trace out all its ramifications. An opening might very probably be found on the opposite face of the mountain; also to ascertain the existence or otherwise of organic remains in the muddy soil."—*Calcutta Gov. Gaz.*

5. *Account of the Burning Mountain in Australasia, called Mount Wingen, near Hunter's River.* By the Reverend Mr Wilton of Paramatta.

The accounts which have already been given of this mountain represent it as a regular volcano with a distinct crater, but Mr Wilton finds this to be a mistake, and has furnished us with the following very interesting description of the phenomena which it exhibits, which he has published in the *Sydney Gazette.*

"There is," says he, "no mouth or crater at all, nor does such an opening lie between the peaks of two mountains which the blacks have called Wingen. That part of the Mount Wingen, where the fire is now burning, and which is a compact sandstone rock, comprehends parts of two declivities of one and the same mountain.

"The progress of the fire has of late been down the northern and highest elevation, and it is now ascending with great fury the opposite and southern eminence. From the situation of the fire having been in a hollow between two ridges of the same mountain, Mr Mackie was probably induced to give to the clefts in the mountain the appellation of a crater. The fact is, the rock, as the subterraneous fire increases, is rent into several concave chasms of various widths. I particularly examined the widest of these. The rock, a solid mass of sandstone, was torn asunder about two feet in width, leaving its upper and southerly side exposed to view; the part so torn

asunder having split, as it were, down, and sunk into a hollow, thus forming the convex surface of the heated rock. I looked down this chasm to the depth of about fifteen feet. The sides of the rock were of a white heat, like that of a lime kiln, while sulphurous and steamy vapours arose from a depth below, like blasts from the forge of Vulcan himself. I stood on that portion of the rock which had been cleft from the part above, and on hurling stones down into the chasm, the noise they made in their fall seemed to die away in a vast abyss beneath my feet. The area of the mountain over which the fire is at present raging, may be about half an acre in extent. There are throughout it several chasms varying in width, from which are constantly emitted sulphureous columns of smoke, the margins of these being beautiful efflorescent crystals of sulphur, varying in colour from the deepest red orange, occasioned by ferruginous mixture, to the palest straw colour, where alum predominated. The surface of the ground near these clefts was too hot to permit me to stand any length of time upon it; neither were the vapours arising from them by any means the most grateful to the lungs. A black tarry and lustreous substance I observed on the edges of several of the clefts. No lava or trachyte of any description was to be met with; neither did I see any appearance of coal. There is a spring of excellent water on the ascent of the mountain by the southern side, for which I would advise every future pilgrim to these regions to keep a good look-out, for he will find a draught of its cooling water not at all disagreeable after the suffocating vapours from this subterranean fire. The height of the burning part of Mount Wingen above the level of the sea, calculating from Mr Cunningham's elevation of the extreme summit of the neighbouring Liverpool range, may be about 1500 feet. In my opinion, the action of combustion in this mountain has been going on for a length of time, far preceding the memory of man—far before the present generation of blacks—and that it will continue to advance. Materials from beneath have from time to time been ignited, whether by electricity or by any other unknown cause, which, struggling for vent, have burst forth by the expansive power of heat and steam, and have shivered and split into huge mas-

ses the solid rock of sandstone, and thus formed continued chasms. On a portion of the mountain, which exhibits an appearance of disruption similar to that where the fire is at present in action, there are trees growing of considerable age, and which must have sprung up since the period when the fire raged over the ground on which they are situated, for every tree that grew on the spot now burning, as well as on that which has lately suffered from combustion, has been destroyed, and the trunks of many are lying on the surface half consumed. I ascended the highest summit of the mountain, which is above the present and more recent scene of desolation, and found that its upper ridge and sides, to the extent perhaps of 100 acres, had been, as it were steamed, many of the stones upon it bearing the appearance of vitrification, and this part of the mountain was covered with trees, many of which are evidently of a great age. It is stated in Mr Mackie's account, that for about a mile and a-half downwards, there was no appearance whatever, save a few sindered stumps, of vegetation going forward—not a patch, not a blade of grass appeared to cheat the eye to the mouth of the crater for a mile and a-half below; all is wide, barren, and waste. At the period of my visit there were both trees and grass within a few feet of the portion of the mountain now on fire. Within a few yards of this spot I could observe that the cast of a shell in sandstone was picked up, and in a gully at the base of the mountain I remarked the presence of black limestone, while here and there were scattered over the side of the mountain blocks of red sandstone and fragments of ironstone. I also found, on my ascent, some small specimens of calcedony and agate.

"I have compared the phenomena presented by this mountain with written descriptions of volcanic action and subterraneous fire in other portions of the globe, but can discover no exact similarity between them. The burning mountain of Australia may, I think, be pronounced as unique—one other example of nature's sports—of her total disregard, in this country, of those laws which the philosophers of the old world have since assigned her.

"To those who may be of opinion that coals form one of the

principal substances which afford a supply of fuel to the voracious appetite of Wingen, I beg to observe that I found fragments of that mineral in the bed on the Kingdom Poas, about seven miles from the mountain. The neighbouring country is evidently a coal formation. This mineral has been found on Colonel Dumaresk's estate, at St Hiliars; at Mr Ogilvie's, at Merton; at Bengala, Captain Wright's; at Dr Bowman's, on the Taybrook; at Mr Glennie's, on the Falbrook; at Mr Scott's on the Westbrook; besides, in great abundance, at Newcastle and Lake Macquarie, on the shore, of which latter locality a very fine layer of excellent cannel outcrops from beneath that of the common description.

"Earthquakes are, we know, of frequent recurrence in volcanic countries; and if we refer to the almanack of the late lamented editor of the Sydney Gazette, we shall find that shocks have been felt in Australia several times since the first settlement of the colony. In the years 1788, 1800, 1804, and 1806, such are recorded. And on the 30th of October of last year, the sky being lurid, and the atmosphere sultry, a loud report, like the discharge of heavy ordnance, was heard at Paramatta, East Creek, Prospect, and Sydney, in a direction from north to south. A similar report was also heard at Paramatta about two years ago; and I was credibly informed that a tremendous noise, resembling the sudden springing of a mine, was noticed in the neighbourhood, and from the direction of the burning mountain, previous to its discovery in 1828."

ART. XIV.—*Description of a Method of Cutting Screws, with drawings of the apparatus employed.** By JAMES CLARK, Steeple Clock and Machine Maker, Old Assembly Close, Edinburgh. Communicated by the Author.

THE method of making screws which I am now about to describe, is the best which has suggested itself in the course of thirty years experience, and combines simplicity with great accuracy.

* The Gold Medal of the Society of Arts for Scotland was given to Mr Clark for this communication and relative drawings, 17th June 1829.

The first thing to be executed is the tap, Fig. 4, Plate III. L is a steel rod, on which is cast a brass cylinder H, and which must afterwards be turned quite cylindrically, and screwed with a comb-screwing tool of the pitch required. Into the cylinder is to be cut five or seven dovetail grooves running parallel to its sides, and the dovetails pointing to the centre, as exhibited in the section Fig. 5, and into these grooves are to be fitted pieces of steel, K K, Fig. 4, precisely the length of the cylinder, and which are kept in their places by a screwed nut (G I, Fig. 4.) at each end. The steel rods must now be cut conformably to the screw in the brass; then taken out, and hardened with as low a heat as merely to bring them to a spring temper. The screw is next to be worked entirely off the body of the brass cylinder, and the steel cutters restored, each to its proper groove, and prevented from shifting by the nuts G and I.

This tap is intended merely to mark the brass bushes in the frame represented by Fig. 1, the construction of which will easily be understood by a little attention to the drawing, of which Fig. 2 is a top view, or transverse section. Spaces must be cut into the brass bushes A A, following the obliquity of the marks made by the tap; and into these spaces are to be inserted cutters made of plate steel, Fig. 6.

The piece intended to be screwed must be turned as nearly as possible into a perfect cylinder; and to reduce any inequalities that may be left by the turning tool, there must be cast on the cylinder a piece of lead eight or ten inches long, which is to be sawn longitudinally through the middle. The metal is then to be laid on an even surface or table, and ground in the direction of its length by one of the lead sections, until it become smooth, and all its inequalities disappear.

The cutting now commences. The first tier of cutters must be brought nearly to a sharp edge, so as to make rather a deep impression, observing that they must be made to *cut* and not to *force*, as in this case they will throw up what is termed a false thread; and, if the diameter of the intended screw be small, may lengthen the rod, and thus not only enlarge the thread, but probably produce a screw of unequal pitch.

The second set of cutters will likely finish the screwing

part, which will, however, depend on the length and diameter of the screw.

After the screw is brought to a sufficient depth, the steel cutters are to be taken out and copper grinders to be put into their places, and the screw to be worked through till it be perfectly adjusted. Two or three sets of the copper grinders may be necessary.

By these methods I have cut screws from twelve to forty-eight inches in length, the accuracy of which has been proved by tests of the severest description.

Make a nut to fit the screw to be proved; fix the nut to the under side of a board or bench, and introduce the screw, which must now be furnished with a micrometer head or index. The screw is now to be made fast at both ends upon a table, but free to revolve, and upon this table is fastened a stage rising above the bench, and at right angles to the axis of the screw, the stage having a sliding point. Place now on the upper board two straight slips of brass, laid edge to edge; set the index, and draw a line across the brass slips; turn the index, say 90° or $\frac{1}{4}$ of a revolution, draw another line and repeat the operation till you have a sufficient number of lines. Let now the slips be shifted, and bring any two lines to coincide; if the whole lines always coincide after the slips are repeatedly shifted, the screw is perfect. Parallel straight lines may thus be produced at any distance.

The leading screw E of the circular dividing machine, Fig. 7, is made by the process already described of making a screw for producing equidistant parallel lines, but it must afterwards receive a certain curvature. Cast a lead wheel one diameter of the leading screw larger than that in which the screw is destined to work, and considerably thicker. Turn a semicircular groove into the periphery of the lead wheel to embrace one-half of the screw, which is now to be worked into the groove till a full impression is made in the lead, then ground with emery till it have acquired the same curvature, and it is then to be connected with the other parts of the machine represented in the drawing, the purpose of which is to produce the screw G, the centres of the threads of which are not parallel; but if produced, would converge and meet at a point.

If this screw be applied to wheel-work, its accuracy may be tried in a way analogous to that resorted to for proving the correctness of the screw for drawing parallel lines.

Make two round brass plates, one smaller than the other; sink the smaller into the larger plate till the surfaces of both are in the same plane. Fix these plates on the machine moved by the screw G; set the index and draw a line on both the plates; move the screw a given number of degrees; draw another line, and continue this operation till you are satisfied that a sufficient number of lines has been drawn. One of the plates is now made to revolve, and any two of the lines on the exterior and interior plates brought together; if the screw be correct, all the other lines will coincide.

It is needless to describe the construction of the parts necessary to the accomplishment of this proof.

ART. XV.—*Memoir on the Fossil Bones of Saint-Privat-d'Allier, (in the province of Velay, France,) and upon the basaltic district in which they have been discovered.* By M. J.-M. BERTRAND DE DOUE, Member of the Society of Agriculture, Science, Arts and Commerce of Le Puy, of the Geological Society of London, &c. *

IT may not be amiss to premise, that the discovery of the fossil bones of St Privat had its origin in the following circumstance:—Dr Hibbert, in an excursion from the Cantal to Le Puy en Velay, crossed the granitic mountains of La Margeride, and took the unfrequented route, little known to geologists, of Monistrol d'Allier and St Privat. At the latter place, Mrs Hibbert, who accompanied him, drew his attention to some small specks of a whitish substance interspersed in a bed of volcanic tufa and cinders, conceiving it at first to be fossil wood, similar to what she had often assisted him in discovering in the volcanic district of the Lower Rhine. But upon an examination of this substance, he found it, to his surprise, to be osseous instead of ligneous matter. His hammer, as well as the pickaxe of a labourer from an adjoining house, were

* From the *Annals of the Society of Agriculture, Sciences, &c. of Le Puy.*

therefore called into requisition, and several fragments of bones were exposed to view in a section which was replete with instruction. It was evident that the animals whose remains were thus found, had lived during a period when the deposition took place of the tufa and scoriæ in which they were imbedded; and that whatever might have been the cause which had induced the inhumation, the bones had been afterwards covered over by renewed torrents of basaltic lava. Hence, a sort of geological date was given to the existence of these animals, as well as to the volcanoes with which they were contemporaneous. The extraction, however, of the fossil bones Dr Hibbert found to be a laborious undertaking, as they lay immediately under the superimposed mass of columnar basalt, already mentioned, which it was not easy to undermine without such extensive and even hazardous excavations, as it was not prudent for him to attempt without permission of the proprietor of the land. Contenting himself, therefore, with bringing away a few interesting specimens, among which was a part of the *os femur* of an animal of some magnitude, and a portion of bone attached to a piece of slaggy basalt, to which it had adhered while in a fluid state, he was only intent (particularly as he was obliged to immediately cross the Alps of Italy,) that the further search after the animals thus entombed should be entrusted to some individual residing in this country, who, from the local advantages which he would possess, was the best enabled to prosecute with effect an investigation, which was calculated to throw no inconsiderable light upon certain obscure questions that continue to interest geologists. Accordingly, the name of a scientific gentleman, well known for his zeal in this department of science, instantly suggested itself to his mind. To M. Bertrand-Roux, therefore, (now M. Bertrand de Doue,) the very able illustrator of the geology of the Velay, he addressed himself, and not in vain; as the following memoir sufficiently attests.

"In the month of September 1828, Dr Hibbert of the Royal Society of Edinburgh, in examining a flow of lava which lined the road from Puy to Sauges, near the village of Saint-Privat, perceived bones of a very great dimension in the volcanic

scoriæ upon which this flow reposed. Gratified with a discovery so unexpected, he set himself to work, and by the help of the inhabitants of a neighbouring house succeeded in disengaging a certain quantity of them; but nearly all fractured and more or less friable.

"Upon his arrival at Le Puy, Dr Hibbert did me the friendly favour of coming to see me; he showed me these bones to which, with reason, he attached much value, on account of the rarity of fragments of organized bodies being contained in volcanic rocks. Most of them were still adherent to their *gangue*, but in such a state of deterioration, that it would have been difficult to determine them if we had been reduced to the sole testimonies of comparative anatomy. It was only by inductions drawn from the age of the ground in which they were buried, that we considered them as belonging to those mammalia, which had formed a part of that third succession of terrestial animals, the remains of which are dispersed in the ancient alluvial soils. To conclude, Dr Hibbert, with that disinterestedness which characterizes the true friend of science, described to me the place where he had found them, and engaged me to visit them, by assuring me that there was still a rich harvest to be hoped for.

"M. Deribier, to whom I hastened to communicate this discovery, thought, like me, that it was too interesting to be neglected. Some days afterwards we both went to Saint-Privat. It was not difficult to recognize the site which had been indicated to me by Dr Hibbert: but having been more fortunate than him, in an excavation which was carried as far as it was possible to accomplish under the superimposed basalts, we collected not only bones in a very great quantity, but also some portions of skeletons, of teeth, and of fragments of maxillary bones very well preserved.

"But before examining to what genera of animals these curious remains have belonged, it would be proper that some notion be conveyed of the general character of the site, as well as of the nature and extent of the district in which they have been found."

[The author, in this part of his dissertation, has entered into

a long explanation of the geological features of this portion of the district of Velay, which, we fear, would scarcely be intelligible to the reader without a reference to the large map annexed to his "*Description geognostique des Environs du Puy,*" and, indeed, without the assistance of the volume itself, to which the present memoir serves as a very useful appendix. We shall therefore endeavour in our own words to abstract so much of the substance of the author's researches, as is necessary to be understood, in connection with the circumstances under which the deposit of fossil bones has taken place.

In the province of Velay in France, the river Allier, which takes its rise from more distant mountains, runs for a distance of nine leagues a course not very far from parallel with the Loire; a chain of volcanic mountains extending from S. S. E. to N. N. W., and from three to four leagues or more across, separating the two rivers. These dividing mountains have primary rocks for their base, which here exhibit a junction of granite with gneiss, the latter being found near the Allier, as we approach St Privat. Along this line numerous flows of lava issuing from volcanic mouths may be traced, which, from their relations of superposition, and from the nature of the products ejected, have evidently belonged to ages the most recent of the long period during which subterranean fires have ravaged the soil of the Velay. Some of the flows of lava in issuing from the ridges of the chain, have fallen into the Loire; while others, of an enormous magnitude, have emptied themselves into the bed of the Allier. During the occasional intervals of these eruptions, we are assured by the result of the discovery which is the subject of the present memoir, that this chain of mountains was inhabited by different races of animals, which harboured in the lateral vallies connected with the Allier. One of these small vallies, that of Saint-Privat, takes its rise from the heights of Vernet, from which several streams of lava have issued, most of which, in following the slope of the defile, have served to fill up an intermediate expanse of hollow near Mercœur. Some of these flows, however, have greatly extended their course; one of them terminating in a narrow ravine to the east of Saint-Privat; another losing itself in a small valley, ordinarily without water, which descends

from the same village; while a third, a very considerable stream of basaltic lava, has descended nearer to the Allier, where, in covering rocks of gneiss, it has formed a sort of plateau, which passes under the village of Saint-Privat-d'Allier, and advances towards the south as far as the parsonage. With the description, therefore, of this plateau, as connected with the deposit of the fossil bones, we shall resume M. Bertrand's narrative.]

"This plateau is formed of modern lavas in large prismatic masses; it reposes immediately upon the gneiss, and in this place is not covered over. It is evidently the remains of a flow of lava, the lateral and anterior parts of which have been almost entirely carried away by the waters. Traces of it have been quite effaced upon the left bank, and in order to find them again on this side, we must ascend as far as the bridge newly erected on the road to Le Puy, where we may detect them in the bed of the stream. But here, this first flow, which I regard as the most ancient, since the plateau of Saint-Privat, to which it is attached, has gneiss for a base;—here, I say this first flow is covered over by a very extensive bed of the scoriæ of craters in a state of agglutination, (*Pépérine rougeâtre*, Brong. *Brèche scoriacée*, Nob.) which separates it from a second flow, distinguished by large inflected prisms, sometimes coupled together, above which we still see one or two others, issuing, like the preceding ones, from adjacent craters.

"Again, in setting out from the bridge, we find that this second flow forms, along with the bed of scoriæ which it covers, a vertical escarpment that follows the windings of the road as far as Saint-Privat, and the continuation of which we observe on the other side of the village, until we arrive above the house Besqueut, which is distant from it about 250 metres.

"Some bones have been extracted in this space of the bed of the scoriæ, but in a very small number; their principal site being near this house in a part of the escarpment which is opposite the plateau of Saint-Privat, from which it is separated by a small valley, commonly dry.

"At this point, the bed of scoriæ is elevated a metre only above the road; but its thickness is more considerable, for it

is only at some paces from thence, that we see issuing from below the soil the first mentioned flow, which is that upon which it reposes. These scoriæ, which contain a certain quantity of crystals of black or greenish pyroxene, have moreover all the characters of those to which we have given the name of "scoriæ of craters," from the immense quantity of them which volcanic mouths hurl into the air. Their black colour is concealed by an earthy cement, commonly of a brick-red colour, rarely yellow, which is in a great measure the product of their decomposition; and this is sometimes so abundant, that the breccia assumes an earthy or tufaceous aspect. And when, on the contrary, the scoriæ are only feebly agglutinated, we learn, from the perfect preservation of the most delicate of their vesicles, that they have suffered no transport, and that they are still upon the same place in which they fell.

"This bed is here covered over by a layer from two to four decimetres thick, of grayish volcanic cinders, with fine grains, feebly agglutinated, above which reposes the second flow, which is about four metres thick. It presents here the same characters of structure and composition that it has exhibited above the bridge, where we first perceived it. Lastly, a third flow, the lava of which is well distinguished from the lower ones by a larger quantity of grains of pyroxene and of peridote, is immediately superimposed upon it.

"It is from thence, that, in a space of two square metres, being from the higher portion of the bed of scoriæ, there has been extracted, by the care of M. Deribier and myself, well characterized remains of many animals belonging to the orders of carnassiers, of pachydermata, and of ruminantia."

[From the above account it appears, that the order of superposition, in tracing the rocks from above downwards, is as follows:

Third and last flow of Basaltic Lava.
Second flow, four metres thick.
Greyish Volcanic Cinders two to four decimetres thick.
Agglutinated Scoriæ and Tufa one or more metres thick, in the upper layer of which the fossil bones were discovered.
Oldest plateau of Basaltic lava.
Gneiss.

This tabular view is given for the sake of greater perspicuity.]

"These remains consist of bones almost all fractured, and of teeth, the greatest part of which were discovered still adhering to their maxillary bones. They were found dispersed without any order, lying cross-wise the one upon the other, but disposed to a horizontal position. The bones are whitish, light, tender, and often extremely friable; their cavities are commonly filled by a reddish cement, which is the same substance as their *gangue* to which they adhere. In other respects, they do not appear to have been in any way altered by the heat of the lavas which covered them. The teeth present similar characters, with the exception of some parts of the enamel, which do not so readily suffer an encroachment from the adhering cement."

[The account of these animals is accompanied with three very well executed lithographic representations by M. Vibert, Member of the Academy of Le Puy. Of the characteristic specimens thus found, which were submitted by Dr Reynaud of the same town to the judgment of Baron Cuvier and of M. Rousseau, assistant-naturalist of the cabinet of comparative anatomy in Paris, the result of the examination was as follows:—Two molar teeth of the lower jaw were referred to the *Rhinoceros leptorhinus*, or Rhinoceros of Italy. Other bones were considered as belonging to the *Hyæna spelæa*; the Hyena of the caverns, or of Germany,—a species analogous to the living spotted hyena of the Cape: while a great proportion of other bones were referable to at least four indeterminate species of *Cervi*, one of which was of a very considerable magnitude.]

"We see by this enumeration, that such a portion of the site of Saint-Privat as we have been able to explore, has furnished the debris of a considerable number of Cervi of different kinds and ages, of at least two hyenas, and of a Rhinoceros. And there is no doubt that if the superimposed basalt could be detached, and if the excavations which M. Deribier and myself

undertook, could without danger be continued, a still greater number of bones would be discovered.

" From the works published during late years on certain analogous associations, we are enabled to concisely explain how the remains of animals, differing from each other as much in their organization as in their habits, should be found crowded together in so small a space. It will be therefore sufficient for me to avail myself of some of the facts which Dr Buckland has related, in his *Reliquiæ Diluvianæ*, upon the habits of modern hyenas; taking, however, into consideration, that a diminished stature, and other anatomical considerations, would induce us to regard them as less ferocious than fossil hyenas.

" They do not dig for themselves dens, says Dr Buckland, but retire into holes or into the lurking-places of wolves. They live principally on the flesh of animals naturally dead. It is in the night that they seek their prey, and that they carry off even skeletons, the flesh of which the vultures have picked clean. Wherever a dead camel or any other animal is thrown, they collect in troops of six, eight, or sometimes more, and, acting in concert, sometimes drag him to a considerable distance. The strength of the hyena's jaw is such, that in attacking a dog, he begins by biting off his leg at a single snap. Hyenas have the custom of devouring in a great measure the bones of the animals of which they make their prey; they afterwards collect the remains of them round their haunt, whence it happens, that in a mass of this kind, we cannot collect a skeleton or even a single bone that is entire, with the exception of teeth, and the small joint bones, or the inferior extremities, which are either too hard for them, or are deprived of marrow. Lastly, it appears, that the carcases of hyenas are in their turn devoured by such of their own kind as survive, &c.

" In reconciling these facts with the different circumstances which the site of Saint-Privat presents, it becomes easy to decide upon the causes of the accumulation of these bones in the volcanic scoriæ. We may conceive, in fact, that in a country where the structure of the rocks is little favourable to the natural formation of caverns, carnivorous animals have sought in this aggregate deposit of a feeble consistence the kind of shelter which they required. Hence it is extremely probable that

this place has been a haunt of hyenas, and that the bones which are thus accumulated are the remains of such as they had gnawed.

"The nature of the superimposed materials again instructs us, in a manner no less satisfactorily, how these animals have been buried; for it is evident, that it was by an eruption posterior to that from which the lavas and scoriæ underneath have proceeded. But this event is local and accidental, being in connection with causes the action of which is only manifested at intervals, and upon spaces more or less circumscribed. We ought, above all, to consider it as quite independent of the great revolution by which is explained the destruction of this numerous population belonging to ancient alluvial lands, of which the species found at Saint-Privat are incontestibly a part.

"It is very likely, on the other hand, that at the time of the eruptions which covered these remains with cinders and with lavas, the carnivorous animals, to whom the accumulation of the bones was due, were not destroyed; but that, flying at the approach of the fiery currents, they went in quest of some new retreats in places more or less contiguous.

"Thus, the age of the most modern of our volcanoes is necessarily confounded with that in which these races of animals lived; and since among their spoils, scattered on the surface of the globe, there has not hitherto been found those of our own species, we may consider ourselves authorized in concluding, that consecutive generations of them were the only witnesses of the last conflagrations of the Velay.

"Nevertheless, the absence of all ancient alluvium above the last flows and the scorified matters which accompany them, does not authorize us to infer, that the general disappearance of these animals has even an approximative coincidence with the epoch in which our volcanoes ceased to be in action. Yellowish ferruginous sands, muddy or micaceous clays, or beds of rolled stones, separate, it is true, in the basin of Le Puy, superior tertiary or sedimentary deposits from the basalts. These substances even exhibit several renewed alternations with flows of lava, and with more or less thick beds of volcanic breccias (breccioles volcaniques, Brong.); but they are always covered over by one or more flows, or at least are to be detect-

ed on the surface of the soil in only a small number of points, in which it is easy to recognize, that the superimposed basaltic masses have been forcibly carried thither by the waters. All these observations induce us likewise to regard these transported materials as having been exclusively derived from surrounding rocks, and as having been transported and deposited under the waters themselves of this basin. We cannot then award to them the name of *diluvium* in the sense which we commonly attach to this word, except to distinguish them from *alluvium*, the result of actual waters.

" I have on another occasion (*Description geognostique des Environs du Puy, p.* 188, *et suivantes*) explained the phenomena which in the circle of Le Puy have appeared in succession during the volcanic period, and to which we must recur, in order to include in our calculation the formation of these transported materials. But if we nevertheless persist in wishing to consider them as having been caused by the invasion of the sea, which has dispersed the true diluvium over the surface of the plains, and caused so great a number of races of animals then existing to perish, we must be constrained to admit, that a very considerable portion of the basaltic land is of a date posterior to this great catastrophe. But is this conclusion admissible after the discovery of antediluvian remains of animals between the more recent volcanic flows ? or is it not at least obligatory upon us to suppose, that some individuals among them had escaped destruction ?"

[These are some of the conclusions to which the author of this excellent memoir arrives. Another deduction, remaining to be stated, has a reference to the arguments which appear in the course of the dissertation, and which we have only withheld on account of the interruption which they give to the main narrative,—that the distribution of the lateral vallies connected with the Allier, among which is that of Saint-Privat, is still to day what it was before the volcanic period ; and that since this time, even the direction of the course of the Allier has not experienced any remarkable change. Arguing then, as indeed he has frequently before done, upon the very remote antiquity

of the valleys of the Velay, he concludes after the following manner :—]

"There remains, then, some degree of incertitude in establishing the chronologic relations between the epoch in which the volcanoes of the Velay became extinct, and that in which these animals disappeared from our climates. Notwithstanding,—the existence of their remains is in such correspondence with the facts exposed in the commencement of this memoir, relative to the disintegration of the large basaltic masses of the banks of the Allier, as to induce us to throw far behind historic times the epoch in which our volcanoes ceased to be in action."

[In a note appended to the foregoing memoir, a reference is made to another important discovery of fossil bones in the district of the Velay. This is due to M. Felix Robert, an active naturalist of Le Puy. He pointed out the place of their deposit to Dr Hibbert, and it will be described by him in a future Number of our Journal.]

ART. XVI.—*General view of the Scientific researches recently carried on in the Russian Empire.* In a discourse pronounced at the Extraordinary sitting of the Imperial Academy of Sciences of St Petersburg, held on the 28th November 1829. By Baron ALEXANDER DE HUMBOLDT *.

IF, in this solemn assembly, which evinces so noble a desire to honour the labours of human intelligence, I venture to solicit your indulgence, it is only to fulfil a duty which you have imposed upon me. When I had returned to my native country, after having travelled over the frozen crest of the Cordilleras and the forests of the lower equinoxial regions,—when I was restored to agitated Europe, after having for a long time enjoyed the calm of nature, and the imposing aspect of savage fertility,

* We are glad to be able to lay before our readers the very eloquent discourse of this distinguished traveller and philosopher, who has been so kind as to favour us thus early with a copy of it. It was printed by order of the Academy of Sciences.

I received from this illustrious Academy, as a public mark of its favour, the honour of being made one of its members. Even now it is agreeable to look back to that epoch of my life when that same eloquent voice which you have heard at the opening of this meeting, called me among you, and almost persuaded me, by ingenious fictions, that I had deserved the palm which you had given me. How little could I then conjecture that I should again sit under your presidency, after having returned from the banks of the Irtish, from the confines of China, Songaria, and the borders of the Caspian Sea! By a fortunate combination of events, in the course of a troubled and sometimes laborious life, I have been able to compare the auriferous soil of the Oural and of New Granada; the elevated formations of porphyry and trachyte of Mexico, with those of the Altai, and the Savannahs *(Llanos)* of the Orinoco, with the Steppes of Southern Siberia, which present a vast field for the peaceable conquest of agriculture and to the arts of industry, which, while they enrich nations, soften their manners, and gradually ameliorate the condition of society.

I have been able partly to carry the same instruments, or those of a similar but improved construction, to the banks of the Obi and the Amazon, during the long interval which has separated my two journeys, the aspect of the physical sciences, particularly of geognosy, chemistry, and the electro-magnetic theory, has been considerably changed. New apparatus, I had almost ventured to say, new organs have been created, to bring man into the most intimate contact with the mysterious forces which animate the work of creation, and of which the unequal struggle, and the apparent perturbations are subject to eternal laws. If modern travellers are able to observe in a short time a great part of the surface of the globe, it is to the progress of the mathematical and physical sciences, to the precision of instruments, to the improvement of methods, and to the art of grouping facts and raising them to general laws, that they owe the advantages which they enjoy. The traveller who is fitted for observation, is he, who, by the valuable influence of Academies, and by the pursuits of a sedentary life, has been prepared in the silence of his study. In order to form an accurate judgment of the merit of travellers of different periods, we

must be acquainted with the simultaneous progress of practical astronomy, geognosy, meteorology and natural history. It is thus that the more or less flourishing cultivation of the great domain of science ought to reflect itself in the traveller who wishes to rise to the level of his age; and that voyages undertaken to extend the physical knowledge of the globe, ought, at different periods, to present an individual character,—the physiognomy of a given epoch,—and that they ought to be the expression of the state of cultivation at which the sciences have progressively arrived.

In thus tracing the duties of those who have pursued the same career with myself, and whose example has often roused my ardour under difficulties, I have noticed the source of that small success which your generous indulgence has deigned to honour by public suffrage.

Having happily terminated a distant voyage, undertaken at the command of a great monarch, and having been assisted by the talents of two philosophers whose labours Europe appreciates, MM. Ehrenberg and Rose, I might confine myself at present to lay before you the homage of my warmest gratitude, —I might solicit from him, who, though yet young, has dared to penetrate into ancient mysteries, (the memorable sources of the religious and political civilization of Greece,) to lend me his eloquence, that I might express more worthily the sentiments with which I am impressed. But I know, Gentlemen, that eloquence which is not in accordance with the sincerity of the heart will not be sufficient in this assembly. You have been entrusted in this vast empire with the great and noble mission of giving a general impulse to the cultivation of the sciences and literature, to encourage labours connected with the actual state of human knowledge, and to stimulate and enlarge the powers of the mind, in the field of the higher mathematics and of terrestial physics, and in that of the history of nations illustrated by the monuments of different ages. Your views have been directed to the career which is yet to be pursued; and the tribute of thanks which I now offer you,—the only one indeed worthy of your institution, is the solemn obligation which I take to continue faithful to the cultivation of science, even to the last hour of a life already advanced,—to explore nature un-

ceasingly, and to follow in the route which you and your illustrious predecessors have traced.

This community of action in the higher studies,—the reciprocal aid which the different branches of human knowledge derive from each other,—the efforts made simultaneously in the two continents, and in the vast extent of the ocean, have given a rapid impulse to the physical sciences, in the same manner, as after the barbarous ages, simultaneous efforts gave an impulse to the progress of reason. *Happy is the country whose government yields a noble protection to letters and the fine arts, which not only delight the imagination of man, but augment also his intellectual power, and give energy to his noblest thoughts;—to the physical and mathematical sciences which have such a happy influence on the progress of industry and public prosperity;*—to the zeal of travellers, who, forced to penetrate into unknown regions, or to examine the riches of the soil, or to obtain a correct knowledge of its surface. To recount at first a small part of what has been done in the year which is about to close, is to render to the Sovereign a tribute which, by its very simplicity, must be agreeable to him.

While in the Oural, the Altai, and the Caspian Sea, the efforts of MM. Rose, Ehrenberg, and myself, were directed to the geognostic constitution of the soil, the relations between its elevations and depressions indicated by the barometer; the variations of terrestrial magnetism in different latitudes (particularly the increase of the inclination, and of the intensity of the magnetic forces;) the interior temperature of the globe; the state of humidity of the atmosphere by means of a *psychrometrical* instrument which had never before been employed in a distant voyage; the astronomical position of places; the geographical distribution of vegetables, and of several groupes of the animal kingdom hitherto little studied—of the philosophers and intrepid travellers who smiled at the dangers of the snowy summits of Elborouz and Ararat.

I congratulate myself in seeing safely returned into the bosom of the Academy, him from whom we have derived the most valuable notions on the horary variations of the magnetic needle, and to whom the sciences owe (independent of his ingenious and delicate researches on crystallography,) the discovery

of the influence of temperature on the intensity of the electro-magnetic forces. M. Kupffer has lately returned from the Alps of Caucasus, where, after the long migrations of the human species in the great shipwreck of nations and of languages, so many different races have taken refuge. With the name of this traveller is associated the labours of a philosopher who has struggled with a noble perseverance on the flanks of Ararat, (considered as the classical soil of the earliest and most venerable recollections of history,)—against obstacles which were opposed to him, both by the depth and the softness of eternal snow. I am almost ashamed to wound the modesty of a father in adding, that M. Parrot, the traveller of Ararat, sustains in the sciences the lustre of hereditary celebrity.

In the more eastern regions of an empire, for ever illustrious by the labours of my countryman Pallas (pardon me, Gentlemen, for claiming for Prussia a part of that glory which is sufficient to distinguish two nations at once,) in the mountains of the Oural and of Kolyvan, we have followed the more recent routes of MM. Ledebour, Meyer and Bunge, and MM. Hoffmann and Helmersson. The fine and numerous Flora of Altai has already enriched the botanical establishment of this capital, which has risen almost as by enchantment, through the zeal of its directors, to the rank of the first botanical gardens of Europe. The learned world expects with impatience the publication of the Flora of Altai, of which Dr Bunge himself was able, in the vicinity of Zmeinogorsk, to show to my friend, M. Ehrenberg, some interesting productions. This was, without doubt, the first time that a traveller in Abyssinia, in Dongola, Sinai, and Palestine, had climbed the mountains of Riddersky, covered with perpetual snows.

The geognostic description of the southern part of the Oural was entrusted to two young philosophers, MM. Hoffmann and Helmersson, one of whom had first made known the volcanoes of the South Sea. This selection was due to an enlightened minister,—a friend of science and of its cultivation,—M. Le Comte de Cancrin, whose affectionate care and provident activity will never be forgotten by my colleagues and myself. MM. Helmersson and Hoffmann, pupils of the celebrated school of Dorpat, have successfully studied, during two years, the diffe-

rent branches of the Oural mountains,—from the great Taganai and the granites of Iremel, to beyond the plateau of Gouberlinsk, which is connected farther south with the mountains of Mougodjares ; and to Oust-Ourt, between Lake Aral and the Caspian Sea. Even there the rigour of winter did not prevent M. Lemm from making the first astronomical observations in this arid and uninhabited country. We enjoyed the great pleasure of being accompanied for nearly a month by MM. Hoffmann and Helmersson, and it was they who first showed us near Grasnuschinskaia a formation of volcanic amygdaloid, the only one which has been yet found in the long Ouralian chain which separates Europe from Asia,—which presents on its eastern declivity the most abundant eruptions of metals,—and which contains, either in veins or in the detritus, *gold*, *platina*, *the osmiuret of Iridium*, *the diamond*, (see this Number, p. 261) discovered by Count Polier in the alluvium to the west of the high mountains of Catschcanar, *zircon*, *sapphire*, *amethyst*, *ruby*, *topaz*, *beryl*, *garnet*, *anatase*, discovered by M. Rose, *ceylanite*, and other valuable substances found in India and the Brazils.

I might extend the list of the important labours of the present year of his Majesty's reign, by mentioning the trigonometrical operations of the west, which, by the united labours of MM. General Schubert and Tenner, and of the great astronomer of Dorpat, M. Struve, have made known on a great scale the figure of the earth ;—the geological constitution of Lake Baikal illustrated by M. Hess ;—the magnetic expedition of MM. Hansteen, Erman and Dowe, justly celebrated over all Europe, and the most extensive and the boldest that was ever undertaken by land, (from Berlin and Christiania to Kamtchatka, where it joined the great labours of Captains Wrangell and Anjou) ;—and, finally, the circumnavigation of the globe, which Captain Luetke has executed by order of the Sovereign,—a voyage abounding in fine astronomical, botanical, physical, and anatomical results, with the co-operation of three excellent naturalists, Dr Mertens, Baron Kittliz, and M. Postels.

I have ventured to notice this community of efforts by which several parts of the empire have been explored, by carrying

into them the aid of modern knowledge, new instruments, new methods, and views founded on the analogy of facts already known. It is also by a community of interests, that, launched once more into the career of travels, I have thought it right to adorn my discourse with names which are dear to science. After having admired the riches of the mineral kingdom and the wonders of physical nature, we love to celebrate (and it is an agreeable duty in a foreign land, and in the midst of a listening assembly,) the intellectual riches of a nation, the labours of men useful and disinterested in their devotion to the sciences, who either travel through their country, or in solitude prepare, by calculation and experiments, the discoveries of future generations.

If, as we have proved by recent examples, the vast extent of the Russian empire, which exceeds that of the visible part of the moon, requires the concurrence of a great number of observers, this same extent presents also advantages of another kind which have been long known to you, Gentlemen, but which, in relation to the actual desiderata of terrestrial physics, do not appear to have been generally enough appreciated. I will not speak of that immense scale on which, from Livonia and Finland to the South Sea which washes Eastern Asia and Russian America, we may study, without going out of the empire, the stratification and formation of rocks of all ages,—the spoils of marine animals which the ancient revolutions of our planet have engulphed in the bosom of the earth,—the gigantic bones of terrestrial quadrupeds whose congeners are lost, or live only in the tropical regions. I will not fix the attention of this assembly on the aid which the geography of plants and animals (a science scarcely yet blocked out,) will some day derive from a more profound and specific knowledge of the climateric distribution of organized beings, from the happy regions of the Chersonesus and of Mingrelia,—from the frontiers of Persia and Asia Minor to the sad shores of the Frozen Sea. I shall confine myself at present to those variable phenomena whose regular periodicity, confirmed by the rigorous accuracy of astronomical observations, will conduct directly to the discovery of the great laws of nature.

If they had possessed in the school of Alexandria, and at the brilliant epoch of the Arabs, (the first masters of the art of ob-

serving and interrogating nature by experiment,) the instruments which belonged to the great age of Galileo, of Huyghens, and of Fermat, we should have now known, by comparative observations, if the height of the atmosphere, the quantity of water which it contains and precipitates, and the mean temperature of places have diminished since those times. We should have known the secular changes of the electro-magnetic charge of our planet, and the modifications which may have taken place, either from an increase of radiation, or from internal volcanic changes, in the temperature of the different strata of the globe, which increases with the depth. We might have known, in short, the variations in the level of the ocean, the partial perturbations which the barometrical pressure produces in the equilibrium of its waters, and the relative frequency of certain winds, depending on the form and condition of the surface of continents. M. Ostrogradsky would have submitted to profound calculations these data, accumulated for centuries, as he has recently resolved with success one of the most difficult problems in the propagation of waves.

Unfortunately, in the physical sciences the civilization of Europe is not of remote date. We are, as the priests of Sais said of the Hellenes, a new people. The almost simultaneous invention of those organs which bring us nearer to the material world, as the telescope,—the thermometer,—the barometer,—the pendulum, and that other instrument, the most general and powerful of all,—the infinitesimal calculus, are scarcely older than thirty lustra. In this conflict of the forces of nature, a conflict which does not destroy stability, the periodical variations do not seem to go beyond certain limits: They cause the whole system to oscillate (at least in the present state of things, since the great convulsions which have buried so many generations of plants and animals,) round a mean state of equilibrium. But the value of the periodic change is determined with a degree of precision proportional to the interval which has elapsed between the extreme observations.

It is to scientific bodies which are renewed without interruption; it is to academies,—to universities,—to different learned societies in Europe, in the two Americas, at the southern extremity of Africa, in India, and in that Australasia lately so

uncivilized, and where there has already risen a temple of Urania, that we must look for regular observations, to measure, and to watch, as it were, whatever is variable in the economy of nature.* The illustrious author of the *Mecanique Celeste* has often expressed verbally the same thought in the bosom of the Institute, where I had the happiness of sitting with him during eighteen years.

The western nations have carried into different parts of the world these forms of civilization,—this developement of human knowledge, whose origin remounts to the epoch of the intellectual greatness of the Greeks, and to the gentle influence of Christianity. Divided by language and manners, by political and religious institutions, enlightened nations form in our day (and it is one of the happiest results of modern civilization) but a single family, when they are occupied with the great interests of science, of letters, and of the arts,—of whatever, having its origin within, raises man above the vulgar wants of society.

In this noble community of interest and action, most of the important problems relating to terrestrial physics which I have above noticed, may doubtless become the object of simultaneous researches; but the immense extent of the Russian empire in Europe, Asia, and America, presents peculiar and local advantages well worthy of one day occupying the attention of this illustrious society. The impulse given from such a height would produce a powerful activity among the philosophers and observers with whom your country is honoured. I venture to point out at present, and to recommend to your special care, three objects which are not (as was formerly said in a misconception of the connection of human knowledge,) purely speculative, but which closely affect the most material wants of life.

The art of navigation, the study of which, encouraged by the highest suffrage, has assumed (under the direction of a great navigator,) such a fortunate developement in this country,—the art of navigation has required for centuries a precise knowledge

* This Observatory was the work of our eminent countryman Sir Thomas Brisbane, whose fate it seems to be to have his labours every where praised, and even the observations which he established, published, without the mention of his name!—Ed.

of the variations of terrestrial magnetism in the declination and dip of the needle, and in the intensity of its force; for the declination of the needle in different countries, which is more exclusively required by sailors, is intimately connected in theory with the other two elements, the inclination and the intensity as measured by oscillations. At no preceding epoch has the knowledge of the variations of terrestrial magnetism made such rapid progress as within the last thirty years. The angle which the needle forms with the vertical and with the meridian of a place, —the intensity of the forces which I have had the good fortune to observe from the equator to the magnetic pole,—the horary variations of the declination,—the inclination and the magnetic intensity often modified by the aurora borealis, earthquakes, and mysterious motions in the interior of the globe,—the starts or non-periodical perturbations of the needle, which, after a long course of observations, I have distinguished by the name of *magnetic storms*, have become in their turn the object of the most elaborate research. The great discoveries of Oersted, Arago, Ampere, Seebeck, Morichini, and Mrs Somerville, have disclosed to us the mutual relations of magnetism with electricity, heat, and solar light. There are only three metals—iron, nickel, and cobalt, which become loadstones. The astonishing phenomenon of the magnetism of rotation, which my illustrious friend, M. Arago first made known, shows us that almost all the bodies of nature are transiently susceptible of magnetic action. The Russian empire is the only country which is traversed with two lines of no declination,—that is, in which the needle is directed to the poles of the globe. One of these two lines, whose position and periodical motion of translation from east to west are the principal elements of a future theory of terrestrial magnetism, passes, according to the latest researches of MM. Hansteen and Erman, between Mourom and Nijni-Novgorod; the second some degrees to the east of Irkoutsk, between Parchinskaia and Iarbinsk. We do not yet know their prolongation to the north, or the rapidity of their motion to the west. Terrestrial physics requires the complete trace of the two lines of no declination at equidistant epochs, every ten years for example, —the precise absolute variations of inclination and intensity in all the points where MM. Hansteen, Erman, and I, have ob-

served—in Europe, between St Petersburg, Kasan, and Astrakan,—in Northern Asia between Iekaterinebourg, Miask, Oust-Kamenogorsk, Obdorsk, and Jakoutsk. These results cannot be obtained by strangers who traverse the country in one direction, and at one time. It is necessary to establish a system of observations well arranged, continued during a long space of time, and confided to philosophers established in the country. *St Petersburg*, *Moscow*, and *Kasan*, are fortunately placed very near the first line of no declination which traverses European Russia. Kiachta and Verkhné-Oudinsk offer advantages for the second, viz. that of Siberia. When we reflect on the comparative precision of observations made by sea and land with the aid of the instruments of Borda, of Bessel, and of Gambey, we may be readily convinced, that Russia, by its position, may in the space of twenty years cause the most gigantic progress to be made in the theory of magnetism. In entering upon these considerations, I am, so to speak, only the interpreter of your wishes, Gentlemen. The eagerness with which you have received the request which I addressed to you seven months ago, relative to the corresponding observations of the horary variations made at Paris, at Berlin, in a mine at Freyberg, and at Kasan by the learned and laborious astronomer M. Simonoff, has proved that the Imperial Academy will ably second the other academies of Europe in the thorny but useful research of the periodicity of the magnetic phenomena.

If the solution of the problem which I have mentioned is equally important for the physical history of our planet and the progress of the art of navigation, the *second* object to which I wish to draw your attention, Gentlemen, and for which the extent of the empire presents immense advantages, is more closely connected with general wants,—with the choice of cultivation,—the study of the configuration of the soil,—and the exact knowledge of the humidity of the air, which obviously decreases with the destruction of forests and the diminution of the waters of lakes and rivers. The first and the noblest object of the sciences lies no doubt in themselves, in the enlargement of the sphere of our ideas, and of the intellectual energy of man. It is not in an academy like yours, and under the monarch who rules the destiny of the empire, that the investigation of great

physical truths requires the support of a material and external interest—of an immediate application to the wants of social life; but when the sciences, without deviating from their noble and primitive object, can boast of their indirect influence upon agriculture and the arts of industry, (too exclusively called the useful arts,) it is the duty of the natural philosopher to bring forward the relations which exist between the study and the increase of territorial wealth.

A country which extends over more than 135 degrees of longitude, from the happy zone of the olive tree to the climates where the soil is covered only with lichens, may advance more than any other the study of the atmosphere, the knowledge of mean annual temperatures, and what is more important for the cycle of vegetation, that of the distribution of the annual heat over the different seasons. Add to these data, in order to obtain a group of facts intimately connected with one another, the variable pressure of the air, and the relation of this pressure with the prevailing winds and the temperature,—the extent of the horary variations of the barometer, (variations which, under the tropics, transform a tube filled with mercury into a kind of clock with the most undisturbed movements)—the hygrometric state of the air, and the annual quantity of rain, so important to be known for the purposes of agriculture. When the varied inflexion of the isothermal lines shall be traced by accurate variations, and continued at least during five years in European Russia and Siberia;—when they shall be prolonged to the Western Coasts of America, where that excellent navigator, Captain Wrangell, will soon reside, the science of the distribution of heat at the surface of the globe, and in the strata accessible to our researches, will rest on solid foundations.

The government of the United States of North America, deeply interested in the progress of population, and of the varied culture of useful plants, has felt, for a long time, the advantages presented by the extent of its territory, from the Atlantic to the Rocky mountains, from Louisiana and Florida, where sugar is cultivated, to the lakes of Canada. Meteorological instruments, compared with one another, have been distributed over a great number of points, the selection of which has been the subject of discussion, and the annual results, re-

duced to a small number of figures are published by a central committee who watch over the uniformity of the observations and the calculations.—(See this *Journal*, No. xvi. and No. ii. New Series, p. 249.) I have already mentioned, in a memoir where I have discussed the general causes on which the difference of climates in the same latitude depends, upon what a great scale this fine example of the United States may be followed in the Russian empire.

We are fortunately far from the epoch when philosophers believed that they knew the climate of a place when they knew the highest and the lowest temperature during the year. An uniform method, founded on the choice of hours, and on a level with the knowledge recently acquired respecting the true means of the day, the month, and the year, will replace ancient and defective methods. By this labour several prejudices on the choice of culture, on the possibility of planting the vine, the mulberry tree, fruit trees, the chesnut or the oak, will disappear in certain provinces of the empire. To extend it to the most distant parts we may reckon upon the enlightened co-operation of many of the young and well educated officers of the Corps of Mines,—upon that of medical men, animated with a zeal for the physical sciences,—and the pupils of that excellent institution the School of Roads and Canals, in which the higher mathematical studies create an instinctive tact for order and precision.

Besides these two objects of research which we have examined in reference to the extent of the empire, (terrestrial magnetism and the study of the atmosphere which leads at the same time by the aid of barometrical measurement to a perfect knowledge of the configuration of the ground,) I will place a third kind of investigation of a more local interest, though connected with the great question of physical geography. A considerable part of the surface of the globe round the Caspian Sea is found inferior in level to that of the Black Sea and the Baltic. This depression, which has been suspected to exist for more than a century, and measured by the laborious operations of MM. Parrot and Engelhardt, may be ranked among the most interesting phenomena of geognosy. The exact determination of the mean annual barometric height of the town

of Orenburg due to MM. Hoffmann and Helmersson, a levelling by station made by the same observers with the aid of a barometer, from Orenburg to Gourief, the east part of the Caspian Sea; corresponding measures taken during several months in these two places; and lastly, observations which we have recently made at Astrakhan and at the embouchure of the Volga, corresponding at the same time to Sarepta, Orenburg, Kasan, and Moscow, will serve (when all the data are united and rigorously calculated) to verify the absolute height of this interior basin.

On the north side of the Caspian every thing at present appears to indicate a progressive depression of the level of its waters; but without placing too much trust in the relation of Hanway (an old English traveller, otherwise very estimable) respecting its periodical increase and decrease, we cannot deny the encroachments of the Caspian on the side of the ancient town of Terek, and to the south of the embouchure of the Cyrus, where scattered trunks of trees (the remains of a forest) are found constantly inundated. The small island of Pogorelaia Plita, on the contrary, seems to increase and rise progressively above the waves which covered it a few years ago, before the jet of flames which navigators perceived at a distance.

In order to solve completely the great problems relative to the depression, perhaps variable, of the level of the sea and that of the continental basin of the Caspian, it would be desirable to trace in the interior of the land round this basin, in the plains of Sarepta, Ouralsk, and Orenburg a *ligne de sonde*, by uniting the points which are exactly on the level of the Baltic and the Black Sea, which will be compared with marks placed on the coast in the whole circuit of the Caspian, (like the marks placed almost a century ago on the Swedish shores by the Academy of Stockholm) if there is a general or partial, a continued or a periodical depression of its waters, or if rather (as has been conjectured for the whole of Scandinavia, by that great geognost, M. Lepold de Buch,) a part of the neighbouring continent is raised or depressed by volcanic causes acting at immense depths in the interior of the globe. The mountainous isthmus of the Caucasus, composed partly of trachyte and other rocks, which owe their origin to volcanic fire,

bounds the Caspian Sea to the west, whilst it is surrounded to the east with tertiary and secondary formations, which stretch towards those countries of ancient celebrity, of which Europe owes the knowledge to the important work of Baron de Meyendorf.

In these general views, which I submit to your consideration, Gentlemen, I have endeavoured to point out some of the advantages which the physical history of the globe may derive from the position and extent of this empire. I have explained the ideas which were deeply impressed upon me by a sight of the regions which I have visited. It appeared to me more suitable to render public honours to those, who, under the auspices of government, have pursued the same career as myself, and to draw attention to what remains to be done for the progress of science and the glory of your country, than to speak of my own efforts, and to condense into a narrow space the results of observations which require still to be compared with the great mass of partial data which we have collected. I have mentioned in this discourse the extent of the countries which separate the line of no variation to the east of Lake Baikal, from the basin of the Caspian ;—of the valleys of Cyrus and the frozen summits of Ararat. At these names we involuntarily revert to that recent struggle, in which the moderation of the conqueror has increased the glory of his arms, which has opened new roads to commerce, and completed the deliverance of that Greece, which has long been the abandoned cradle of the civilization of our ancestors. But it is not within these peaceful walls that I should celebrate the glory of arms. The august monarch who has deigned to invite me into this country and to smile upon my labours, appears to me as the genius of peace. Encouraging, by his example, all that is true, great, and generous ; he has been pleased, from the dawn of his reign, to protect the study of the sciences which strengthen reason, and of letters and the arts, which adorn the character of nations.

ART. XVII.—*Additional Contributions towards the History of the Cervus Euryceros, or Fossil Elk of Ireland.* By S. HIBBERT, M. D., F. R. S. E., &c. Communicated by the Author.

THE animal, which is the subject of the present memoir, is the *Cervus Euryceros* of Aldrovandus; the Irish Fossil Elk or moose deer of many writers; the *Cervus giganteus* of Blumenbach; and the *Cervus Megaceros* of Mr Hart of Dublin. As the name which is first given to an animal ought to be retained, unless a sufficient reason can be shown to the contrary, a priority is due to the appellation made use of by Aldrovandus, which for this, as well as for other reasons, I shall persist in using. The name of *Cervus giganteus* proposed by Blumenbach is very objectionable, as it is only the horns of the animal which are gigantic; and for this reason, the term *Megaceros*, which has been used by Mr Hart, is more appropriate, if it could be proved that the Fossil Elk of Ireland is the only known Cervus possessing horns of large dimensions, which I have some reason to doubt. The original name of *Euryceros* has, however, this advantage, that it points to the most characteristic feature of this animal, which is the remarkable width of its wood.

In this paper, it is my intention to give a condensed view of what is actually known relative to the history of the *Cervus Euryceros*, including even what is less determined, in connection with some additional investigations which I have made respecting him, as a very late inhabitant of the wilds and morasses of the temperate regions of Europe; my remarks being intended to serve as a sort of appendix to the geological and historical proofs which I advanced in the third volume of the last series of the *Edinburgh Journal of Science*, that the *Cervus Euryceros* was of a race which had but very recently become extinct. At the same time, I ought to observe, that nearly synchronous with my own paper a dissertation made its appearance, written by Mr Hart of Dublin, who, from a very different series of facts, advocated similar views. This memoir, which I did not see until some months after my paper

was printed, contains one of the best anatomical accounts of the animal which has yet been published.

What is known or unknown regarding this animal I shall now sum up under distinct heads.

1. *The Cervus Euryceros was the contemporary of such extinct animals of Europe as the Elephant, the Rhinoceros, the Hyena, the Hippopotamus, and divers others.*

Cuvier very promptly arrived at this conclusion, which was repeated by Professor Buckland, in the first edition of his *Reliquiæ Diluvianæ*, on the authority of the *gissement* of this animal at Walton in Essex. But since the Fossil Cervus of Ireland and the Isle of Man was proved to have existed at a very recent date, the geologists of the Diluvian School have conceived that they were at fault. The animal has accordingly been transferred from the ancient diluvial clay and gravel, in which he was originally placed, to the very highest alluvial bed of Mr De la Beche's late order of superposition. But that this removal is justifiable, may be very fairly doubted. I am rather of opinion that he ought to again descend to his old associates, the elephant and the hippopotamus, or that *they* ought to move a step higher to *him*, and on this point the fact adduced by Cuvier may be quoted. He has stated that, in excavating the canal of Ourcq, near Sevran, in the forest of Bondi, the remains of this Cervus were found precisely in the same place as the bones of elephants. "On a trouvé dans les fouilles du canal de l'Ourcq, près de Sevran, dans la forêt de Bondi, à six lieues de Paris, précisément au même endroit que les os d'elephans, une parte supérieure de crâne du genre du cerf, avec deux moignons de bois, qui, dans tout ce qui en reste, paroissent resembler au cerf à bois gigantesques." This testimony is decisive, and we may safely assert, that the *Cervus euryceros* or Irish elk, so far from being a recent upstart possessor of the soil of Europe, is entitled to dispute his genealogical distinction with all such supposed families of greater antiquity, as are included in Mr De la Beche's diluvium, under the name of the Mastodon, the Elephant, the Rhinoceros, the Elasmotherium, the Trogontherium, the Megatherium, the Megalonyx, the Tiger, the Hyena, or the Hip-

popotamus, as well as other races which are equally supposed to have been destroyed at the universal deluge. Into the further questions which may arise from this conclusion, I shall not at present stay to inquire; as, for instance, whether the Irish elk was the sole survivor of this catastrophe, or whether his contemporaries, as well as himself, were not severally of less antiquity than is usually supposed. I shall prefer continuing my narrative without reference to the popular geological speculations of the day, which have hitherto been most premature.

2. *The Cervus Euryceros was the contemporary of the earliest inhabitants of the human race dwelling in Europe.*

Remains of this animal, for instance, have been described by Professor Goldfuss of Bonn, as having been found in the Duchy of Cleves at a very inconsiderable depth from the surface of the ground in the same drain with urns and stone axes. And in Lancashire, the same Cervus has been discovered entombed in a bed of turf similar to that from which rude canoes, in the vicinity of the site, have beeen extracted.

3. *The Cervus Euryceros or Fossil Elk of Ireland, so far from being an animal, the existence of which is referable to a remote antiquity, actually lived in the wilds of Prussia so late as the year* 1550, *and perhaps later.*

For this curious fact, at the knowledge of which I have but lately arrived, I am indebted to a scarce folio work entitled, "Cosmographiæ Universalis Lib. VI. in quibus, juxta certioris fidei scriptorum traditionem describuntur, omniū habitabilis orbis partium ppriæ'q. dotes. Regionum Topographicæ effigies. Terræ ingenia, quibus fit ut tam differētes et uarias specie res et animatas et inanimatas, ferat. Animalium peregrinorum naturæ et picturæ, &c. &c. Autore Sebast. Munstero." The date of the publication is given at the end of the work, "Basileæ apud Henrichum Petri, Mense Martio Anno Salutis M.D.L." Sebastian Munster, the author of this work, which he dedicated to the Emperor Charles the Fifth of Germany, was one of the early reformers, celebrated for his knowledge of the Hebrew and Oriental languages, and for his comments on the Old Testament, whence he was named The German Es-

dras; while his equally painful researches, as a cosmographer, obtained for him the additional title of The German Strabo.

In the volume before us sketches of the chief towns of Europe are interspersed along with maps of its provinces, and graphic illustrations of different national manners; and as these are accompanied by narratives remarkable for their perspicuity, Munster has deservedly ranked high among antiquaries. Nor is he less to be commended for the information which he gives of the natural productions of the countries he describes. Several of the animals which he has represented, are drawn with a very laudable exactness, and it is only in such of the remote regions as were imperfectly known to naturalists, that his narratives partake of the popular fables of the times in which he lived. Hence, while speaking of the interior of Africa, he has described, though with little confidence, the men whom our great bard has caused Othello to descant upon,

> ——————————————" whose heads
> Do grow beneath their shoulders ;"—

and in giving a picture of the remoter tracts of Scotland, he has not omitted the Orcadian Claik-geese.

But if an objection lie against the evidence of Munster with respect to regions which were little traversed, (and the same objection lies against every other natural historian of that time), no hesitation whatever of this sort applies to admitting him as a good authority in regard to the productions of a country then so well known as Prussia. Accordingly, in enumerating the animals actually existing in this province in the year 1550, he has given the figure of a Cervus, corresponding so precisely in the form of his immense and wide horns with those of the fossil Elk of Ireland, that it is impossible to confound him with any other Cervus ;—and that there may remain no doubt whatever that the same was an inhabitant of the wilds or marshes of Prussia, he adds, " I ORDERED THE MISSHAPEN FIGURE OF THIS ANIMAL TO BE HERE DEPICTED TO THE LIFE, AS WELL AS CAN BE EXPRESSED IN A DELINEATION." A wood-cut accordingly appears in Munster's volume, which is the only good historical record of this animal which I believe to be in existence. An accurate copy of it is given in the present number

of the journal, (See Plate III. Fig. 9,) upon precisely the same scale as the original delineation.

The written account which Munster has annexed to his representation of this cervus is very brief. It may be given in the author's own words. "Nutrit præterea Prussia animalia quæ putantur esse alces, Germanice autem vocantur Elend, habentque magnitudinem asini aut mediocris equi. Ungulæ ejus dicuntur prodesse his qui caduco laborant morbo, et pellis est tam dura, ut nec confodi neque dissecari possit. Caro ejus dicitur esse ex nobiliori venatione. Color autem subrufus est, nonnihil nigricans, habetque albicantia crura. Figuram hujus animalis ad vivum deformatam et qualiter lineis exprimi potest, feci hic depingi."

This animal Munster compares with other Cervi, but as he afterwards translated his work into the German language, I prefer quoting him from this subsequent version, which was a posthumous publication, particularly as a few slight alterations occur in the text of the latter, which it may be well to notice.*

In the part of the volume wherein mention is made of this Cervus, the author proposes to enumerate the various animals which are to be found in Prussia. But when he comes to the tribe of the Cervi, he is evidently much puzzled in reconciling the different descriptions of them which were published under as many different names. Commencing therefore with a tame animal of this genus, he observes: "This land produces also Bisontes, some Germans call them *Damen* or *Damthier*, that is, animals which are partly like stags and partly like cattle, except that they have long ears, and that the males have broader horns than the stag. One may see many of these horns at Augsburg among the merchants, but they say they

* This edition contains in other parts of the work very numerous and important additions, some of which were made by the author himself. My own copy is unfortunately imperfect, so that I cannot speak precisely to its date. I procured it while travelling through the Duchy of Wirtemberg from the eating-room of a miserable inn, where it was destined to the use of lighting the pipes of German smokers;—numerous mutilated remains of other revered and defunct authors lying strewed about, like the bones of noble animals collected for the use of vile hyenas in one of Dr Buckland's antediluvian dens. The German Strabo was reserved for the next sacrifice, from which I rescued him with the loss only of his title-page.

are Elks' horns." This same animal was probably nothing more than the common fallow-deer, the horns of which, in the prior Latin edition of the *Cosmography*, are said to have been exported from England to Higher Germany.

After the fallow-deer has been thus described, Munster turns his next attention to the cervus, whose horns precisely resemble those of the fossil Elk of Ireland. The account has already been given in the original Latin, from which the German version (of which the following is a translation,) little differs, "For this land," he observes, "possesses animals called *Elks, (Elent,)* and these are as large as an ass, or a middling-sized horse. Their hoofs are good for the falling sickness, snd the skin is so hard that one cannot cut or stab through it. This animal is also good game for eating. Its colour is brown, inclining to black, and the lower parts of its legs are whitish. Its form and shape I have got represented, and have drawn it here."

In this quotation, the only difference in the two editions is, that in the earlier, the animal is described of a reddish, and in the latter of a brownish colour; and that in the Latin copy, the author states that he had the animal drawn *to the life; ad vivum.*

While Munster was obtaining information about this Cervus, he found, that less was known of him than of any other of the genus. He therefore wrote for additional information to a friend in Livonia, conceiving that in that country the animal was more abundant. But his queries, so far from being resolved, were answered by a description of a perfectly different animal, and in such ambiguous language, that our cosmographer found it difficult to say to what race the description was relative. "John Hasentöder," he explains, "who lived many years in Lyffland, has written to me concerning this animal in the following manner:—The elks are greater than stags; they are grey, have long rough hair, a misshapen form, are lower behind than before by a good handsbreadth, have long weak legs, divided hoofs, and spare bodies. They are naturally shy, and a child may drive them where it pleases with a switch. They have long ears like an ass, and will not carry any thing on their backs, and when one lays any thing light upon them, they

bend down with the hind legs till it slides over their back. The male has horns three spans long, with strong broad trochings, out of which people make hafts of knives, and turn handles; but the female has no horns."

Now, regarding this account, Munster is evidently so dissatisfied, that in the remarks which he makes upon it, he states, that "some who speak of the northern animals, would understand this of another animal which the Latins call a *bison*, of which I shall write something by and by in my account of Sweden. For the elk," he adds, "has very strong legs and broad horns with scoops, which are hollowed out like a large deep shell, and which terminate in short teeth or points, from which no knife handles can be made."—In order, therefore, that the Cervus, regarding which he is so anxious to procure information, may not be mistaken, he not only orders a sketch to be taken of this mysterious animal, but he likewise annexes a faithful representation of the true Northern Elk, *(Cervus Alces)* with the view that a comparison between the two might be instituted; adding, that the representation of the true Elk (the *Cervus Alces*) was expressly made for him in Prussia.

Little, therefore, now remains to be added upon the evidence which has been adduced. It is decisive; and it shows, at the same time, that the *Cervus euryceros* was in the sixteenth century becoming the rarest of the ancient tribe of European animals. Soon afterwards, probably, the race became extinct;—though even upon this last question it would be premature to pass a judgment, amidst our imperfect acquaintance with the inhabitants of many of the wilds and marshes which still exist in Europe.

But although the most satisfactory proofs are afforded of the existence of the *Cervus euryceros* so lately as the sixteenth century, we must admit that Munster has recorded little regarding him except what is conveyed in the valuable delineation which he has given. Few, however, as his notices are, they may be considered in connection with what may be collected regarding the animal from other sources of information.

It is rather curious that Munster, in drawing two animals of this species of Cervus, which we shall presume to be male and female, gives to each of them horns; those of the animal

in the front of the drawing, which we shall suppose to be of the male sex, being somewhat larger and more inflected than those of the female. The coincidence of this delineation with the observations of Baron Cuvier and Mr Hart, but more particularly of the latter, is very striking. The former observes, " Quant aux bois, ils varient, ainsi que l'on devoit s'y attendre, néanmoins je n'ai jamais vu ni entendu parler de tête qui en fût dépourvue, en sorte qu'il est à croire que dans cette espèce, comme dans celle du renne, les deux sexes avoient des bois." And to this opinion, that the female possessed horns, after the manner of the reindeer, Mr Hart subscribes, for the following reason. He has observed " that these parts present differences in size and strength which appear not to be dependent on differences of age; for instance the teeth of the specimen in Trinity College are much more worn down, and the sutures of the skull are more effaced than in the specimens described in this paper; yet the horns of the latter are much more concave and more expanded than in those of the former; and on comparing a single horn of each of these specimens together, that belonging to the society exceeds the other by nearly a sixth in the length, and little less than a third in the breadth; it is not therefore unlikely that the animal whose horns were larger and more curved was a male."

Munster has estimated the animal to be about the size of an ass or a middle-sized horse. Perhaps the latter standard is the most correct; and it meets with a familiar, yet striking, illustration in the fact, that when the blacksmith of the Isle of Man, who put together the noble skeleton which now adorns the Edinburgh Museum, discovered that he was short of some few of the bones, he supplied the deficiency from those of the horse, which he found from repeated trials to be the nearest to them in dimensions, and, as such, the least liable to be detected; which circumstance affords a better criterion of the comparative size of the animal than can be conveyed by the appearance which he actually exhibits in the Edinburgh Museum, as he is set up much too high, with the view of rendering his trunk as gigantic as his horns. His true height has in this instance been calculated at about five feet to the withers.—Whether the specimen of Dublin is wholly free from this objection I will not pretend

to say. The height of him to the upper extremity of the dorsal spine, has been given at six feet six inches. He certainly appears in the portrait published of him to be at his utmost stretch. Judging also from the size of the cranium of the animal, we are scarcely warranted in conceiving of him as either being so tall or so long as he is thus represented. Cuvier on this subject says, " Il faut remarquer que la tête fossile ne suivoit pas pour la grandeur la monstreuse proportion de son bois: au contraire, les plus grandes têtes fossiles sont plus courtes que des têtes ordinaires d'élan." (*Ossemens Fossiles*, vol. iv. p. 79.)

Munster next speaks of the animal as possessing a figure which is every thing but well proportioned, aspersing it under the term *figura deformata*. He is certainly represented in the sketch as possessing a heavy, bulky trunk, little calculated for motions of celerity, with a small head, and such immense horns as to make his body appear comparatively short; which description so well corresponds with the Cervi mentioned by Giraldus Cambrensis as existing in Ireland during the 12th century, that it is impossible to resist the testimony, that he is actually describing them in their living state. " Cervos præ nimia pinguedine minus fugere prævalentes, quantoque minores sunt corporis quantitate, præcellentius efferuntur capitis et cornuum dignitate."

Another part of Munster's description, remaining to be noticed, relates to the animal's skin and hair. The skin is said to be so hard as to be cut through or stabbed with difficulty. The hair is described as of a reddish or brown colour, inclining to black; the lower parts of the legs being whitish. But the most remarkable trait in Munster's delineation of the animals, is the circumstance of the neck and breast being defended by such long shaggy hair as truly adds to their *figura deformata*. This singular appendage of long hair, by which they are distinguished from almost every other Cervus, gives some weight to the conjecture of the Countess of Moira, who, upon the occasion of a human body being discovered in a gravel bed of Ireland under eleven feet of peat, which owed its complete preservation to being soaked in bog water, conceived that the antique garment of hair with which it was

clad were derived from the fossil Cervus of the country.—(See the seventh volume of the *Archæologia Britannica.*)

Such is the account given by Munster of the animal's general form and figure, from which, in reference to what we know of the anatomy of the fossil skeleton, there is little or nothing to dissent. It might, perhaps, be objected, that the brow antlers of Munster's Cervus do not project sufficiently downwards over the forehead. But I believe it will be found, that there are not only mutual incongruities in this respect among individuals of this one species, but that different notions of this appearance are conveyed according to the position in which the head is drawn. In the present instance, the brow antlers somewhat resemble those which are engraved in the fourth volume of Cuvier's *Ossemens Fossiles,* Plate 7. (p. 106) Fig. 3. It ought also to be recollected, that this antler has been found to differ in different individuals in more important respects. Thus, it has been seen to divide itself into two or three points, or to show no division of this kind at all.

But it would be unfair to criticise, with too much minuteness and severity, a drawing, accompanied with a description, made nearly three hundred years ago, during the very infancy of our knowledge of natural history, and at a time when the race described was evidently becoming extremely rare, if not extinct; and this forbearance is the more demanded as an act of justice, in a case where the essential and permanent characteristics of the form and figure of the animal appear to be given with such a degree of accuracy and fidelity, as to render it impossible that we should confound them with those of any other race of Cervi then known to be in existence. If, however, some slight discrepancies should be insisted upon, I am quite willing that Munster's Cervus be considered as a variety only of the *Cervus euryceros,* or Fossil Elk of Ireland, analogous to such varieties as we find in the breed of horses, of dogs, of foxes, of wolves, or of hares.

But I now proceed to notice other circumstances connected with the natural history of the *Cervus euryceros,* or fossil elk of Ireland.

4. *The Cervus Euryceros was an animal attached to a marshy state of the country.*

This is evident by the more frequent occurrence of his remains among the extensive bogs of Ireland than in any other portion of the British dominions; where, according to Mr Hart, his bones are so abundant, that in the county of Antrim, a pile of them was used for making a bonfire in celebration of the Battle of Waterloo. Further proofs of the *Cervus euryceros* being an animal that frequented marshes are supplied in the fact, that his remains are generally found in, or near, recent and extinct fresh water lakes and pools, associated with such plants as the birch, the willow, the alder, ferns, reeds, &c. It also appears that he gave a preference to such waters as were favourable to the accumulation of shell-marl; this predilection, as I have shown in a previous memoir, being common to many other Cervi of the present day. Hence the very frequent inhumation of his remains in deposits of this nature, the circumstances of which I have described at large in a former number of this *Journal*, and which I need not now repeat.

The food of the animal probably resembled that of the moose; consisting of the leaves of the willow, the alder, and other aquatic plants, the small branches of which his horns would assist in breaking. But while he frequented the low woods of marshy grounds, there can be no doubt that he avoided tall and dense forests, the progress through which would be impeded by his vast horns.

5. *The chief use of the immense horns of the Cervus Euryceros was probably for his defence.*

The natural enemies of this animal were, no doubt, the European hyena and tiger, the bear, the wolf, and other carnivorous animals, many of which are extinct, who were his contemporaries. Mr Hart on this subject has properly observed, that, if we consider the powerful muscles for moving the head, whose attachment occupied the extensive surfaces of the cervical vertebræ, with the length of the lever afforded by the horns themselves, we can easily conceive how he could wield them with a force and velocity which would deal destruction to any enemy, having the hardihood to venture

within their range. The same writer also correctly remarks, that the lateral expansion of the horns is such, that should occasion require the animal to use them in his defence, their extreme tips would easily reach beyond the remotest parts of his body.

6. *The Cervus Euryceros was the ancient inhabitant of the temperate regions of Europe.*

It is doubtful if this animal dwelt farther north on the Continent of Europe than the country south of the Baltic, where his place began to be supplied by the *Cervus alces* or Norwegian Elk. In Prussia, according to the testimony of Munster, both these animals occurred; the habitat of the more northern animal commencing where the other was ceasing. Whether the British Islands were ever to be regarded as a similar joint habitat is doubtful. A solitary relic of the *Cervus alces* is said to have been found in the Isle of Man,* but as I could not learn, after much inquiry, that remains of the true *Cervus alces* had been either before or since found in the Island, the relics in question, supposing that they have been accurately described, appear to be rather referable to accidental circumstances. It is well known, for instance, that in a very early period the Isle of Man was possessed by the Northern Vikingr, who, in introducing among the people whom they invaded their customs and laws, might have occasionally brought over the products of the mother country, and among them the Northern Elk, which, from the testimony of Olaus Magnus, was domesticated and highly valued by the Northmen as a beast of burden. We have, in fact, historical as well as other proofs to show, that certain races of animals at present existing in other early Norwegian provinces, as in

* This account I published on the authority of Mr Burman, a respectable surgeon and resident of Douglas, who himself saw a portion of the horns, and conceived it to resemble the wood of the Norwegian Elk, with which he was familiar, from a specimen of the same being in his possession. But on my visiting the island afterwards, the horns, whatever they were, which Mr Burman failed in procuring, had certainly fled; nor could I obtain any satisfactory account of them, as such fossil relics were in general surreptitiously disposed of, to obviate the paramount claims of possession which were set up for them by the superior of the soil.

Orkney and Shetland, were referable for their introduction to Scandinavian settlers.

But if the habitat of the *Cervus euryceros* was bounded on the north of Europe by the Baltic, I believe that it was no less limited on the south; for it is very doubtful to me whether any true remains of this animal have ever been discovered south of the Alps. The horns referred to him, said to have been fished out of the Po, of which I possess a sketch made for me at Turin, are those of some other species of Cervus, apparently undescribed. Brocchi's list, therefore, of the organic remains found in the north of Italy, which are said to resemble the ancient moose-deer of Ireland, demands a re-examination; and until this is done, I must regard the *Cervus euryceros* as having inhabited such temperate regions of Europe as lie between the Baltic and the Alps, while his chief abode was in the British islands, and particularly in Ireland.

7. *The causes which led to the Extinction in Europe of the race of the Cervus Euryceros were various, while their action was gradual.*

Some of these causes, though they must be necessarily obscure, I shall endeavour to investigate.

The first of these causes of extinction was owing to the *Cervus euryceros* being an object of the chace.

This cause of gradual extinction may be traced for a long period of time. Mr Hart has related, that in a rib of the animal presented by Archdeacon Maunsell to the Royal Dublin Society, he discovered an oval opening near its lowest edge, the long diameter of which was parallel to the length of the rib, its margin being depressed on the outer and raised on the inner surface, round which there was an irregular effusion of callus. "This opening," adds Mr Hart, "was evidently produced by a sharp pointed instrument which did not penetrate so deep as to cause the animal's death, but which remained fixed in the opening for some length of time afterward; in fact, such an effect as would be produced by the head of an arrow remaining in a wound after the shaft was broken off."

Mr Whittaker has conceived that the fossil Cervus of Ireland and other places, acquired among ancient British hunters

the title of *Segh*, which he has found in an Irish glossary to signify not only an ox, but a deer of the moose sort. Professor Goldfuss again supposes, that this Cervus was known to German hunters of the olden time under the name of the *Schelk;* and he quotes the lines of an ancient poem, in which a hero, Sifrid, is made to slay a bison, an elk, four uri, and a schelch:

> Dar nach schluch er schiere einen wisent und einen elch
> Starcher Ure viere, und einen grimmen Schelch.*

In Munster's time, we are informed by him in the German edition of his work, that the animal was esteemed good game for eating; but in the Latin copy he has lauded the venation more strongly. "Caro ejus dicitur esse ex nobiliori venatione:" adding, that the hoofs were in estimation for medicinal purposes, being good for the falling sickness.

Regarding the mode in which the animal was hunted and dispatched, we have little or no information. We should be led to suspect, by the term *grimmen* Schelch, that he was considered as a formidable object of the chase. Munster says that his skin was with difficulty cut through or stabbed. Mr Hart has supposed that the Irish wolf dog was his natural enemy: but Mr Whittaker is rather inclined to confine the fierce and fleet talents of this individual to the pursuit of the red deer; fixing at the same time upon a huge Lancashire dog, formerly known under the name of the *Kibble hound*, as the ancient antagonist of the British moose deer.† His arguments are founded upon the supposed slowness of the motions of the Cervus, and the corresponding slowness of his pursuer; upon the great bulk of the game, and the corresponding size of the chacing foe; upon the fierceness of the English moose deer, and the proportionable strength of jaws manifested by the Kibble hound. "The formidable armoury," says this author, "which the segh carried about him in his branching antlers, required the segh-dog to be at once animated with a

* I have not had an opportunity while writing this paper of consulting the work of Professor Goldfuss alluded to; being indebted for this quotation to Mr James Wilson, in his excellent Illustrations of the History of Domesticated British Animals. See the *Quarterly Journal of Agriculture*.

† The breed is, I believe, lost. It is celebrated by the poet Drayton.

considerable resolution for the attack, and furnished with strong fangs for the hold." But with regard to the peculiar "tuneable cry,"—the "sweet thunder" emitted from the throats of this race of dogs during the pursuit, Mr Whittaker is not so perspicuous. We may suppose, if we choose to adopt the same hypothetical trace of reasoning, that it would be availed of to drive the animal by alarm into soft boggy places or dense thickets, where, being entangled either by his feet or his horns, he would be the more easily destroyed. In the case of the Canadian elk, which is also the tenant of marshes, the Indians, by the assistance of dogs, chace him into the water, where he is dispatched by spears aimed at him from canoes; (See *Carver's Travels*, p. 272;) and as canoes resembling the American ones have been extracted from the nearly extinct lake of Martonmere in Lancashire, near to which gigantic horns have also been found, it is no extravagant supposition, upon the principle that the manners of a savage people are in all ages and countries the same, that a similar mode would be occasionally resorted to for the destruction of the large horned Cervus of our own country, while dwelling among his ancient swamps and morasses.

A second cause contributing to the extinction of the *Cervus euryceros*, was the estimation in which all the remarkable animals inhabiting Gaul as well as other regions were held by the Romans for the use of the public games. The number in requisition for this purpose is well known to have been astonishingly great. Hadrian in one day slaughtered a thousand beasts; Titus, five thousand. The Emperor Gordian, in inventing a new kind of spectacle, had a wood planted in the Circus, into which there was turned out wild horses, wild asses, wild sheep, wild boars, elks, bulls, ostriches, and ibices, and among these two hundred deer and two hundred *Cervi palmati*; and in a subsequent spectacle of the same kind given by Probus, among a similar variety of animals no less than one thousand stags and one thousand deer were at the same time exhibited; the people being allowed, as an addition to the sport, to enter the wood and take from thence any which they had the courage to face. That many of these

Cervi came from Britain, is evident by the remark of Julius Capitolinus regarding a picture of the memorable wood of Gordian, which existed in the house of Cneus Pompeius: "Gordiani sylva memorabilis picta in domo rostrata Cn. Pompeii picturas animalium diversas continet, inter quas sunt cervi palmati ducenti mixtis Britannis."

In reference to this quotation, I was lately rather anxious to identify, among the numerous animals which were depicted in the interior of the houses of Pompeii, a representation of the ancient race of the *Cervus euryceros*. Some few delineations I certainly found of Cervi with gigantic horns, but they were in general ill expressed; the same inaccuracy, indeed, prevailing in many other representations of individuals of this genus. I think I was more successful in an ancient sculptured monument, of which a drawing was taken for me while I remained at Rome.

From the exhibition of the *Cervus euryceros* at the Roman games, it is most probable that the ancients, and more particularly Oppian, who lived in the reign of Caracalla, derived their notion of the animal, which they have described as resembling the stag in the length and thickness of its horns, and the fallow-deer in the width of them; as exceeding the Βούβαλος in size, and in other respects forming the most eminent of the tribe of Ελαφοί. This was in fact the opinion of the industrious and the learned Aldrovandus, who was nearly the contemporary of Sebastian Munster; and as at this time skeleton heads of Cervi, possessing gigantic horns, were beginning to attract the attention of naturalists, Aldrovandus, in studying the character of some which had previously been submitted to the observation of Bellonius, added "Suspicorque cornua illa ingentis magnitudinis, quæ in gradibus et ascensu Ambrosianæ arcis conspiciuntur, non vulgaris damæ, ut Bellonius existimat, fuisse, sed vel alcis vel alterius." Applying, therefore, to the animal possessing these vast horns, the character under which Oppian has described the most distinguished of known Cervi, he was the first to conceive of the same under the appropriate title of the *Cervus euryceros*.

But the third and last cause which may be mentioned as

having contributed to the extinction of this race of Cervi, is one that is strictly geological. It is the gradual obliteration of the ancient pools and lakes, to the swampy banks of which they originally resorted. Most of these, by dint of the constant operation of atmospheric agents affecting the disintegration of rocks, combined with other, yet subordinate, causes, have, by the transported materials of rivers, been gradually filled up, so as to at length present a surface well adapted to the use and abode of man; and when our Cervus was eventually deprived of the covert of morasses and thickets, he became the more easy prey of his natural enemies, whether of the human race or of the lower animals. According to this view, then, which I have amply illustrated in a former essay, the diminution or extinction of this very interesting race of Cervi has kept pace with the obliteration of ancient lakes, and the drainage of ancient marshes.

I have at length concluded my history of the *Cervus euryceros*. But, as the validity of a favourite geological theory has been involved in it, I would merely hint, that the object of the present memoir was not to determine a question of this nature, but one of zoological history. For the valuable services which Dr Buckland has rendered to geological science, I continue to entertain the same respect which I have always done; and I even agree with him, that illustrations of the Mosaic testimony are to be expected from the study of the actual appearances of nature. But with this general admission I would pause:—the present essay will perhaps convey the information, that such illustrations must be sought for amidst phenomena totally different from those, which geological commentators on the holy writ have entangled in the articles of their creed.

ART. XVIII.—*Investigation of the Spherical Aberration of a Diamond Lens.* By Mr ANDREW PRITCHARD, Hon. Mem. Soc. Arts, Scot. &c. Communicated by C. R. GORING, M. D.

As the superior distinctness and efficacy of a diamond lens does not yet seem to be sufficiently appreciated by the public

at large, owing no doubt to the want of a simple comparison of its spherical aberration with that of glass and other substances of lower refractive power, I have in the present paper endeavoured to demonstrate in a familiar and tangible manner its real longitudinal aberration.

Plate III. Fig. 8, represents a section of two semi-lenses. They are both convexo-plane. The upper one D is the form of a diamond lens of the same magnifying power and semi-aperture with the lower one G, which represents one formed of glass.* F is the principal focus of the two lenses for inside rays: d and g are the focal points of their outside rays. Hence the space F d, will be the longitudinal aberration of the diamond lens, and g F that of the glass lens. This geometrical illustration will, I hope, address itself with sufficient force to the eyes of those least imtiated in such matters; but I have availed myself of the work of Mr Coddington to compute the spherical aberration according to an expression given by him in page 93 of his work, which is as follows:—

$$-\tfrac{1}{2}\left\{\frac{1}{\mu^2(\mu-1)^2}+\frac{(\mu+1)(\mu-1)}{\mu^2}\right\}\frac{y^2}{f}.$$

If we assume the refractive index of diamond to be 2,5 (μ) as a mean, (it ascends as high as 2,755) then the above formula, executed in numerical computation, will stand as follows:

$$-\left\{\frac{1}{2,5)^2(2,5-1)^2}+\frac{(2,5+1)(2,5-1)}{2,5)^2}\right\}\frac{y^2}{f}=\frac{3}{7}\frac{y^2}{f}$$

nearly, or about $\frac{3}{7}$ of its *own* thickness, while it is well known that the aberration of a glass lens of the same form, and in the same position, is $\frac{7}{6}$ of its *own* thickness. But as the thickness of a diamond lens will be considerably less than that of a glass one of the same power and aperture, it will be necessary to compute them respectively; and it will be found, by taking the proportions given in the geometrical illustration, to be for the diamond 255, while the thickness of the glass one will be 758.

* In the construction of the figure I have assumed the radii as 8 to 3, it having been found by careful experiment, that the powers of a diamond and plate glass lens of the same radii are to each other as 8 to 3. These proportions will of course vary a little according to the refractive indices of the stones employed. The lenses in the figure are slipped a little for correction of thickness, to make the focus F fall in the same point.

Hence $\frac{5}{7}$ of 255 will be the longitudinal aberration of the diamond lens, viz. 108; and $\frac{7}{8}$ of 758 that of the glass, viz. 884; or in other words, the diamond will only possess about *one-ninth of the actual aberration of a glass lens of the same power and aperture.* * It will therefore be obvious, that the diamond gains its advantage in two ways, *first*, its spherical aberration, *enunciated in terms of its own thickness*, is far less than that of glass; and, *secondly*, this said thickness is also far less than that of a glass lens of the same power and aperture, and these two quantities compounded express its actual aberration. Again, it must not be forgotten, that the violent refraction of the diamond (which is the cause of its faint *spherical* aberration,) happens to be associated with a dispersive power also lower than that of glass; for, had its dispersion been in proportion to its refraction, so much colour would have been generated by it, as to counterbalance the advantage of its low spherical aberration. I regret that I have not as yet introduced a perfect plano-convex of diamond to the notice of the public, but I am now on the point of supplying that defect, and trust, from the fair promise of perfection given by the stone in its flat state, when it showed no traces of flaws or polarization, that it will turn out satisfactorily.

312, Strand, Andrew Pritchard.
4th February 1830.

Art. XIX.—*Account of another remarkable Case of Spectral Illusion.* Continued from Art. IV. p. 222 of this Number.

It was nearly a month after the last occurrence, that Mrs —— was preparing for bed at about eleven at night, after a somewhat fatiguing drive during the day, and sitting before the dressing-glass occupied in arranging her hair. She describes her state of mind at the time as listless and drowsy, but fully

* It should be remarked, that, to give the greatest effect to the diamond, it must be formed into a *meniscus* lens, having the radii of its surfaces as 2 to 5 nearly, when the aberration would be reduced greatly below that of a plano-convex.—*vide* Mr Coddington, page iii.

awake; indeed her fingers were in active motion amongst the papillotes, when she was suddenly startled by seeing in the mirror the figure of a near relative, (at the time in Scotland,) over her left shoulder; his eyes meeting her's in the glass. The figure was enveloped in *grave-clothes* closely pinned, as is usual with corpses, round the head and under the chin. Though the eyes were open, the features were solemn and rigid. The dress was decidedly a *shroud*, as Mrs ——— remarked even the punctured pattern usually worked in a peculiar manner round the edges of that garment.

Mrs ——— describes herself as sensible of a feeling like what we conceive of fascination, compelling her for a time to gaze on this melancholy apparition, which was as distinct and vivid as any reflected reality could be; the light of the candles on the dressing-table appearing to shine fully upon it. After a few minutes she turned round to look for the reality of the form over her shoulder. It was not however visible; and had also disappeared from the glass when she looked again in that direction.

Coupled with the previous illusions I related to you, this last apparition becomes more interesting than it would be alone. In the first place, its melancholy, and indeed horrible character, distinguishes it from the others, but brings it still nearer to the ordinary stories of supernatural visitation. At the same time, the possible continuance of such spectral appearances is highly disagreeable, however firm the lady's nerves, and however sound her philosophy.

2. The mind in this case seems not to have had the remotest influence in raising or dissipating the illusion.

Mrs ——— is convinced there was no train of thought previously passing through her mind, likely to have the slightest association with the idea of the relative whose form she suddenly saw with all the distinctness of reality.

3. The former illusions might be supposed ideas of sensation, sounds or pictures, reproduced with extraordinary vividness in the same shape and character in which they had been perceived by and stored up in the mind. But in this last case, there is a new combination of ideas, which never entered the mind in connection.

The union of the well known features with the shroud must have been a pure effort of or creation of the mind. There seems, therefore, no reason why, under the same disposition of the nervous system, any monstrous creations of the faculty we call imagination, might not be produced to the eyes and other senses, indeed, with all the qualities that constitute reality, except their endurance, though this should hardly be excepted, since there can be no reason why the appearances may not endure, by a continuance of the conditions, for days or months. I need hardly say that the relative whose ghost was seen after so dismal a fashion, was at the time in perfect health. Had it been otherwise, and that the apparition coincided with illness or death, as has no doubt frequently happened in other instances, our philosophy would have had to stand a severe trial.

ART. XX.—*Notice respecting Mr Cuthbert's Elliptic Metals for Reflecting Microscopes.* Communicated by a Correspondent.

MR J. CUTHBERT has succeeded in obtaining perfect elliptic figures for metals having an aperture equal to their sidereal focus or 54°. The process by which he effects this is very similar to that by which he obtains truly hyperbolic figures for the mirrors of small Gregorian telescopes, of only five inches focus and three inches of aperture. Many artists have attempted to figure small metals having an aperture equal to their focus, but the *true* curve is so perfectly artificial, that they have hitherto been totally unable to attain it. It remained for the unique and peculiar talent of Mr Cuthbert, to accomplish this in metals of half an inch focus, and half an inch of aperture, and three-tenths of an inch focus, and three-tenths of an inch of aperture:—combined with an excellent polish.

When the scale of operation is so very contracted, we leave it to those acquainted with such matters to determine how small an error must inevitably destroy the figure of such minute mirrors.

These metals are adapted to the Amician catadioptric engiscope, (the perfection of which they consummate,) by means of plane mirrors of *very small diameter*, when transparent ob-

jects are viewed, but opaque ones are observed by the direct operation of the unassisted elliptic mirror.

The effect of this instrument, so constituted as to bring out proof objects, which, so far as we know, are invisible by any other engiscope or microscope whatever, viz. a set of *longitudinal lines* on the scales of the Podura, *in addition to the two sets of diagonal ones* already discovered, and two sets of *diagonal lines on the scales* of the cabbage butterfly, *in addition to the longitudinal ones with the cross striæ* hitherto observed. The colours of a variety of objects are shown with uncommon brilliancy, and a great number of delicate touches on a variety of objects are brought out, which have escaped the penetration of other instruments. We shall, in a future number, give the particulars of this grand and capital improvement, which seems to surpass every thing yet executed, although no less than six thin triple object glasses have been preposterously combined together in a *rouleau* for the purpose of accumulating power and giving an unlimited angle of aperture. Such clumsy and complicated constructions can never rival the beautiful simplicity and true vision of perfect reflectors.

ART. XXI.—*An outline of Dr KNOX's theory of Hermaphrodism, and the application of its principles to the generative and respiratory organs*

Part I.—Theory of the generative organs, and of the type according to which they have originally been formed in all animals.

WHEN the genital organs of both sexes came to be particularly examined, anatomists, seeing that some of the female organs resembled the male, and *vice versa*, supposed that they were repetitions of each other, and that they were fundamentally the same organs, only differently developed in the one sex from what they were in the other.

In man it was said that the organs are external, and in woman internal; for in man the uterus is turned inside out to contain the ovaries, now become testicles. In pursuing this analogy, the *vasa deferentia* were compared to the Fallopian tubes, the *vesiculæ seminales* to the uterus, and the penis to the vagina.

This was the opinion of the ancients, and with the following modification is nearly that of all anatomists of the present day; viz. the testicles are still regarded as analogous to the ovaries, but the Fallopian tubes are held to be the epididymi, whilst the angles or horns of the uterus are the parts analogous to the *vasa deferentia;* the analogy between the *vesiculæ seminales* and the body of the uterus, and between the penis and vagina, is still supported.

Many plants and some animals, the lowest in the scale of organization, carry the organs of both sexes; but such is not the case with man and the higher orders of animals, although in them cases do occur in which individuals present the characters of both sexes. These beings are what are called hermaphrodites.

Now, according to the ideas of the formation of the genital organs which I have mentioned, viz. that the male and the female organs are repetitions of each other, and that they are fundamentally the same organs, only differently developed in the one sex from what they are in the other; in accordance with this idea, I say, physiologists accounted for hermaphroditical appearances, by supposing an irregular developement of the genital organs, whereby some of them inclined to the female structure and others to the male. In this way, when such beings were examined and both a uterus and testicles found, it was said, that by a malformation the part out of which the ovaries in the female, and the testicles in the male, are formed, had in this case been converted into testicles.

Entertaining this opinion, it will be difficult to explain on philosophical principles the cases in which both testicles and ovaries, *vasa deferentia* and Fallopian tubes, *vesiculæ seminales* and uterus, occur; for if these organs are identical, they cannot exist together in the same animal.

But if we say that the type of the genital organs is hermaphroditical, that is, that there are fundamentally male and female organs in the same being, or originally in all embryos, elementary yet distinct parts, out of which both sets of organs may be formed by developement, then, I apprehend, we may explain the above-mentioned anomalies.

This, in short, is the key of Dr Knox's explanation of hermaphrodism.

Part II.—Containing the determination of the sexual organs in the male and female, and what is essentially male and which female.

To make this explanation intelligible, we must first determine what are male and what female organs; for in the normal state certain male organs are always developed to a certain extent in the female, and certain female organs in the male. Thus, in woman the clitoris is an organ essentially male, and in man the mammæ are organs essentially female.

The essentially male organs are the testicles, the *vasa deferentia*, the *vesiculæ seminales*, the prostate, Cowper's glands, and the penis.

The essentially female organs are the ovaries, the Fallopian tubes, the uterus, the round ligaments of the uterus, the vagina, and the mammæ.

If a greater or less number of the above kinds of organs be co-existent in the same individual, however analogous they may be, they cannot be said to be fundamentally identical; yet there must be some germ out of which the superfluous organs have been formed.

The most rational opinion is, that the type of the genital organs is, as has been mentioned, hermaphroditical, that is, they at first comprehend the elements of both sexes.

The cause of hermaphrodism is thus explained in a clear and easy way.

The elements of both sexes being present, either the one or the other, according to the regular course of developement, will come to perfection, thus constituting the male sex if the male organs are perfected, and the female sex if the female organs are perfected.

Cases may happen and do happen in which both sets of organs are developed to a certain extent.* What has been said

* In such cases, the two sets of organs have not as yet been observed to be so fully developed as to be fit for the performance of both male and female functions. This, like the sterility of hybrids, is probably dependent on some deep law of the organization. Yet in the case described by Mr Thomas, and that examined by Dr Knox, there was nothing in the anatomical structure which could have prevented one set of organs, the male, from performing their functions; nay, the propensities shown by the animal

above shows, that this is owing, not, as was originally supposed, to the malformation of the single set of elements of organs, which, assuming the female character, determined the female sex, and *vice versa*, but to the simultaneous developement of two sets of elements of organs, male and female, which co-exist, but which in the normal condition of the organs are only singly developed.

Part III.—Application of the new law for discovering the nature of rudimentary organs, by determining the original type of construction, to the respiratory organs;—theory of the respiratory organs, showing them to be at once pulmonary and branchial.

As in some animals both the male and female organs are found together, so also do we find in some animals two structures for the oxygenation of the blood co-existent, or developed one after the other, as in the tadpole.

It is hard to conceive how, if these two organs were identical, as is supposed, they could exist at the same time in one individual, which they assuredly do in the Proteus and Syren. Here the principles, on which hermaphrodism has been explained, may be applied, and we may therefore say, *that the type of the respiratory organs is double; it is both pulmonary and branchial; the elements of both sets of organs are found in all vertebral animals.*

From this it follows, that lungs and gills, although *analogous*, are not *identical* organs, and that they can no more be changed into each other, than male into female organs.

Admitting this, we can now explain certain bones in fishes which have never been exactly determined; these are the bones which support the gills, called by some *ribs*, and by others *hyoid bones*. Lungs and gills are analogous, but not identical organs, the elements out of which the gills are formed, are not the same as those out of which the lungs are; therefore, when we analyze the structure of the gills, and find the branchial arches, we say that they are organs belonging essentially to

which was the subject of the latter case, when alive, are strongly in favour of the probability of this.

the gills. But as the type of the respiratory organs is both lungs and gills, we must expect to meet, in some of those in which the lungs only are developed, with elements more or less remarkable, of the gills. Now such are the hyoid bones, which are in truth the branchial arches.

Part IV.—Theory of those organs whose functions have never been explained, viz. the spleen, thymus, thyroid, and supra-renal capsules; they are supposed to be rudiments of organs whose developement, so as to perform obvious and perhaps important functions, took place only in those animals whose fossil remains proclaim the vestiges of an antediluvian world: they are supposed to be the rudimentary organs of a former world.

Speculating on the principles which have been laid down, may we not explain the existence of certain mysterious organs found in animals, such as the supra-renal capsules, thymus gland, &c. which, as far as we know, have no function either in the embryo or adult state, by supposing that they are the undeveloped elements of the type of a peculiar structure which existed in the animals of the antediluvian world; for we may infer from the peculiarities of the skeleton of those animals, and more particularly of the Sauria, that there had been peculiarities in the soft parts to fit them to live on the earth's surface, which, in all probability, was different at that time from what it is now. T. W. J.

ART. XXII.—*Physical Notices of the Bay of Naples.* By JAMES D. FORBES, Esq. Communicated by the Author.

No. VII.—*On the Islands of Procida and Ischia.*

"——— Tum Prochyta alta tremit durumque cubile
Inarime, Jovis imperiis imposta Typhœo."

Æn. ix.

MY last paper brought the reader to the Capo di Miseno, which terminates the continuous stretch to the westward of the shore of the Bay of Naples. It is, however, virtually prolonged by the two islands of which I propose now to give some

account,—the Prochyta and Inarime, or Pithecusa of the ancients,—the Procida and Ischia of modern times. The nature of the soil on the corresponding coasts, as the *scoglie delle pietre arse* already described, with the conterminous point of Procida, and the little island of Vivara interposed between it and Ischia, bespeak at least a connection in the submarine land, whether or not we may be disposed to admit with Strabo, that the disseveration was accomplished by a natural convulsion within the memory of man. We may therefore consider Ischia, which is farthest from the shore, as the true western extremity of the Bay, the entire opening of which, between this island and the promontory of Minerva, has a stretch of about thirty miles. The islands of Procida and Ischia had a pre-eminence as to volcanic energy in ancient times, which they now want, the latter having been subject to violent earthquakes, and even volcanic explosions, long before the first recorded eruption of Vesuvius, so as to have gained the character of imprisoning the Typhon of the Greeks, that mysterious being represented as "surpassing in size and force all the children of earth,—as taller than the mountains, with the hissing of snakes from his head. Fire gleamed from his eyes, and he hurled stones to heaven with a loud and hollow noise, while surges of fire boiled up from his mouth."* The island of Prochyta was conceived by some to be the offspring of one of the eruptions of the greater island,—an opinion which its name seems to support. † But in later times the energies which were spent in this direction found a more permanent vent in the long dormant crater of Vesuvius, and the western side of the bay has only been subjected to rare though violent paroxysms.

We shall make first a few remarks upon the island of Procida, which, however, presents little to detain us. Notwithstanding the appellation of "*Alta*" which Virgil gives it, this island has in general a flat character. It is the castle alone, which being situated on one considerable eminence at its eastern extremity, gives it rather a commanding appearance in

* See Dr Daubeny on the Typhœus of the Greeks in his Lectures on Volcanos.

† Pliny, *Hist. Nat.* iii. 6.

some points of view. It is entirely composed of tufa, with interposed beds of slaggy lava conformably stratified, and some of the water sections of which present an interesting appearance, as I observed in coasting along its shore, particularly on the western side. The character of the island is very uniform, and is rendered still more monotonous by the complete sacrifice of it to the culture of vines. It is only about six miles in circumference, and in the highest state of cultivation. About the present time the number of its inhabitants may be reckoned at 14,000, and formerly amounted to 18,000; so that in all probability, in proportion to its size, it is the most highly inhabited land in the world, Malta not excepted.

On the island pheasants at one time were preserved with so much strictness for the royal sport, that no cats were allowed to be domiciled, by a decree issued in the year 1750. Lalande mentions a curious anecdote of the result: Rats became so overwhelmingly numerous, that the inhabitants were threatened with absolute destitution, and in a body were compelled to petition against the royal decree. The castle still contains a garrison, and has some pretensions to be considered as a defence to the bay. From the point on which a telegraph is placed, there is a magnificent view of the whole stretch of the Bay of Naples and that of Gaeta,—a view in many respects more satisfactory and picturesque than those obtained from higher points, such as the Camaldoli di Napoli, or the summit of the Island of Ischia.

The north side of Procida is only about two miles distant from the point of Misenum, and the similarity of the corresponding rocks has been remarked by Spallanzani and others. On the south side Breislak thought he discovered symptoms of the original crater of projection in the small island of Vivara, which is at a short distance from the larger mass; but this author's fanciful discrimination of craters has been formerly pointed at. Vivara, however, seems to form a connecting link with Ischia, which is extended by the picturesque detached rock upon which the castle of Ischia stands, united to the land merely by a low bridge of some length. All these features point undeniably to some species of junction between the

coast of Italy and the island of Ischia, as a glance at any tolerable map will at once prove.

I can conceive nothing more perfectly beautiful than the view of this majestic island as approached from the north, especially if under the enchantment of an Italian sunset. There is just that degree of symmetry in its structure which is requisite without formality, and sufficient ruggedness to relieve the surpassing verdure with which nature has clothed the greater part of the island. The peculiar structure of the volcanic mass has given a peaked character to almost every more important part of its outward form. But the degrading nature of the soil, the lapse of centuries, and the action of the waves and of earthquakes, have prevented any thing monotonous in the general configuration, and the whole is grandly surmounted by the majestic summit of Monte Epomeo, which constituting, in fact, almost the whole of Ischia, at once unites, and is supported by its tributary eminences.

The entire surface of the island is so completely intersected with rugged dells, and bestrewed with shivered crags of rock, the work no doubt of those great hands, which, according to tradition, have here so often desolated the face of nature, that travelling is difficult and the roads precarious. Neither horses nor vehicles of any kind exist; and asses (or *ciuci*, as in the debased dialect of this island they are called,) form the only mode of conveyance. Yet, generally speaking, over so rough a foundation, nature has lavished the charms of verdure to a degree seldom met with even in Italy, and there might be found many a sequestered picture of retirement and natural luxuriance, upon which the eye of the traveller, returned to the sterner features of more northern zones, might wish long enough to find, except within the precincts of this favoured island. Various detached masses, such as that we have mentioned as the seat of the castle of Ischia, and many abrupt cliffs, break the sea landscape; and farther inland, though vast quantities of Spanish chestnut and other woods, mostly cut for copse, clothe almost every rising ground, some bare crags arise in the interior of the island, and some lava currents of unbending sterility, break the green slopes of the hills; while the rich mass of brushwood which wraps the enormous

flanks of Epomeo to a great height above the sea, leaves its scarped summit magnificently insulated to every wind of heaven, and its crumbling materials have been picturesquely blanched into a grayish white hue, by the weathering of centuries. Pretty extensive vineyards are in some places cultivated, but such is the profusion of rocky masses, especially on the north side of the island, that the labour of clearing the ground, which is but imperfectly done, is enormous; and in order to dispose of the stones, walls are built round them in great numbers and of immense height, leaving only narrow rugged lanes between, which give the country a most peculiar appearance. The general view from a distance is, however, fortunately not much spoilt by these interminable-looking walls. This arises from the extreme ruggedness of the ground, the abundant interspersed verdure, and the still more fortunate circumstance of the green colour, which tinges all the rocks of this district, and renders them less glaring. So enormous are some of the masses hurled from higher situations, that any attempt to remove them appearing fruitless, they have, from the soft nature of the rock, been hewn entirely out into wine cellars.

The circumference of the Island of Ischia along the water's edge is eighteen miles, its length from west to east only five, and its breadth from north to south three. It contains a considerable number of villages, of which that adjoining the castle of Ischia, and properly called Celso, is the capital, and contains 4000 souls, and the entire population amounts to about 24,000, who live almost entirely on the productions of their vineyards. * Foria is the next largest town to Ischia, and there are besides eight or nine smaller villages, some of which are very straggling. Most of these are close to the sea, and a good deal of fishing is carried on: but the food of the poorer classes consists of dried figs, which are grown on the island. The quantity of grain is so small as to be insufficient for the internal consumption; olives might probably be cultivated with advantage, but owing to their expence, and the time they require before fruiting, they have not yet been introduced.

* Siano, *Notizie dell' Isola d'Ischia.*

Before giving an account of the constitution of the island and its mineral springs, I shall notice one or two facts connected with its physical history. Its revolutions both from history and from observed structure, appear to have been numerous and varied, and, as Dr Daubeny well observes, we here find pumiceous conglomerates corresponding to the Pozzuolana of the Phlegræan fields, trachytes to the rock of the Solfatara, and lavas to those of Vesuvius. Repeated colonies have settled in Ischia: according to Strabo the Erythræans, and afterwards the Chalcidians were among the first, and they were driven away at a very remote period, by the number and violence of the earthquakes. A colony was established by Hiero, king of Syracuse, about 380 years before the Christian æra, * but being engaged in building some fortifications, they were so alarmed by earthquakes and eruptions, that they also left the island. Not very long after this, as we know, Vesuvius began to give symptoms of activity, and a pretty regular course of eruptions followed, during the dominion of the Romans and the middle ages. The volcanic energy which so long had characterized the western extremity of the bay, took a more eastern direction, and materially changed the character of the Ischian volcano, which had a long interval of repose. The eruptions which, on the testimony of Timæus, took place formerly from the summit of the island, then called Mons Epopeus, now took a lower level of emission, and the returning energy in this quarter, which the eruption of the Solfatara in 1198 indicated, not very long after reached Ischia, with a violence which seemed aggravated by the quiescence of centuries. At the close of the 13th century this unfortunate island was distracted by political commotions, and alternately fell into the hands of the houses of Arragon and Anjou, but these evils were destined to be effaced, and the contested spot absolutely divested of inhabitants, and threatened with annhilation by the natural convulsions with which the 14th century commenced. During part of 1301, arth-

* Some confusion has prevailed from the occurrence of two kings of Syracuse of this name, the second of whom lived a century and a half later; it appears, however, to have been Hiero I. who colonised Ischia. See Andria, *Trattato delle acque Minerale*, ii. 38.

quakes succeeded one another with fearful rapidity, and having for two months kept the inhabitants in a state of constant alarm, terminated at last in the great eruption of 1302. The crater, as we have observed, was not in Monte Epomeo, but the lava found its exit near the eastern side of the island, at no great height above the sea, from a point named still the "Campo del Arso." It is not very far from the town of Ischia or Celso, and runs quite down to the sea at no great distance from Casamicciola. Its hardness and sterility is quite remarkable, and is a striking example of the danger of theorizing upon the dates of eruptions by the forwardness of the decomposition of their products: during 500 years it has made less progress than some of those of Vesuvius probably within the last twenty. The length of the stream is a mile and a half, when it joins the sea, and its breadth half a mile; its colour varies from iron-grey to reddish-black, and is remarkable for the glassy felspars which it contains. Spallanzani remarks, that it appears to have been produced under extremely violent heat from the fusion of some of the crystals of felspar; in a specimen which I broke, the augite was collected in crystalline patches. Dolomieu relates that the eruption continued for two years, and is surprised at the want of pumices here observed; but pumice was discovered by Spallanzani, who imputes it to the action of heat on the hornstone, of which, according to him, the base of the lava is formed. The time during which the eruption and its accompaniments lasted, is one of its most remarkable features: the surviving inhabitants (many having been killed by the catastrophe,) deserted the island for a long period, and actually did not return till the year 1305. The accounts we have received of this eruption are by no means very satisfactory, and seem to be chiefly derived from an old author Villani, who wrote a history of Florence.

Since the fourteenth century, Ischia appears not to have been the scene of any very striking indications of volcanic agency, and we are not even informed whether the formation of the Monte Nuovo in 1538 occasioned any corresponding paroxysm. Earthquakes in that country, unless very violent, do not produce much attention, nor are even put on record; one, however, we may mention, from its recent occurrence, as

well as on account of the damage which it produced. On the 2d of February 1828, at eleven o'clock in the forenoon, a violent shock of an earthquake was felt in the north-eastern part of the island of Ischia, which lasted four seconds, accompanied with an undulatory and vibratory motion, which produced great devastation in the village of Casamicciola, where it was principally felt. Many houses were destroyed at the instant, and others so much shattered as to be in danger of falling: twenty-nine persons were buried in the ruins, and many others wounded: —much fear was entertained of greater convulsions, but these were happily averted. The shock was felt over almost the whole island, and appears to have commenced at the base of Monto Epomeo, and stretched through Casamicciola to Lacco, a village to the westward. The air was still, and the sky cloudy; for four days the barometer had maintained its level with little variation, but after the earthquake it fell, though apparently not to a great extent. * These particulars are ex-

* The connection of earthquakes with variations of the barometer, if such connection exists, is a curious subject of inquiry, for upon few matters of fact has there been such direct evidence both for and against the connection. Humboldt, whose means of information in South America were extensive, mentions (*Pers. Narr.* ii. 224.) that no such connection is observed in places affected by earthquakes, yet contrary facts might easily be adduced. During the great earthquake of Lisbon, the fall, if I remember right, was very general. During the earthquakes in Calabria in 1783, it fell to 27.88 at Lyndon. (*Phil. Trans.* 1784.) The surprising depression in December 1821 accompanied the eruption in Iceland and an earthquake at Mayence. A similar phenomenon was observed as far north as Norway during the first great eruption of Vesuvius in 1822; and the extraordinary depression in February 1823 was perhaps connected with an earthquake felt at sea at the same period. (*Ed. Phil. Journ.* x. 378.) Though I cannot say that we have symptoms of the slight Ischian earthquake affecting the barometer in this country any more than on the spot, there can be no doubt of the influence of the succeeding eruption of Vesuvius, March 21, on the barometer at Edinburgh, which attained a very considerable depression that day, as the following observations prove:— March 20, 1828, 8½ M. 28.806 temp. 53., 10 M. 28.770-55., 5 A. 28.674-55., 10 A. 28.650-55. March 21, 9 M. 28.512-50., 10 M. 28.500-52., 5 A. 28.498-53., 8 A. 28.592-55., 10 A. 28.614-55. A tremendous earthquake occurred on the 21st March 1829 in Murcia in Spain. I observed a considerable depression of the barometer near Edinburgh on the 20th, after which it rose almost an inch in twenty-four hours. The shock felt at Copenhagen, 21st August 1829, is said to have occasioned a most extraordinary rise of the barometer there. The most careful comparison of the state

tracted from a letter received from Italy shortly after the event, and in no long time the account of a phenomenon arrived with which it had doubtless a connection, the eruption of Vesuvius on the 21st of March the same year. The locality of the principal shock, it is interesting to observe, coincides nearly with the ancient point of emission of the Ischian volcano, and from the direction in which it reached Casamicciola, it may very possibly have originated in the actual Campo del Arso. It is interesting to observe, that this earthquake was the precursor of this eruption, and that instead of being, as Mr Scrope in his paper in the *Geological Transactions* suspected, the intimation of the direction of volcanic energy to this its ancient seat, it thus proved to be merely the concomitant of its paroxysm in its established point of emission. Thus having briefly noticed the more conspicuous traits of the physical history of Ischia, we proceed directly to give some account of its constitution and products.

The great mass of the island is composed of a rather friable

of the barometer with the occurrence of earthquakes is by La Cotte in the *Journal de Physique*, vol. 65. Many of the shocks were extremely slight and at a great distance from the place of observation. But I shall select at random the more conspicuous which occurred during the space of only four years: I shall classify the state of the barometer under the heads of

Great Elevation.	Great Depression.	Great Variation.	Stationary.
24th Jan. 1775,	6th and 22d Oct. 1775,	4th Feb. 1775,	20th June 1775,
5th Aug. 1776,	7th Feb. 1776,	14th Feb. 1775,	8th Sept. 1775,
5th May 1778,	1st Oct. 1777,	27th Feb. 1776,	30th Dec. 1775,
	18th Jan. 1778,	4th July 1777,	30th Jan. 1776,
	18th Feb. 1778,	23d Sept. 1777,	22d Apr. 1776,
	2d Apr. 1778,		9th June 1776,
	20th Apr. 1778,		1st July 1776,
	1st Oct. 1778,		4th Aug. 1776,
	31st Dec. 1778,		6th Sept. 1776,
			6th June 1777,
			15th Oct. 1777,
			31st July 1778,
			19-26th Dec. 1778.

Here the ratio of the times when the barometer was affected to when it was not are as 17 : 13, and there was only one instance of great elevation to three of great depression. But had the observations included a longer period, and only the more notable earthquakes, both these ratios would probably have been much higher.

species of tufa, on the true nature of which geologists are undecided. Were I to offer an opinion, I should be disposed to coincide with those who consider it a mechanical aggregation of pre-existent materials, such as comminuted pumice, forming of a compound such as may be found in some parts of the Phlegræan fields, though generally more intimate and of a more decided character. It seems admitted, however, that its nature is essentially the same with the conglomerates of Hungary and some of the volcanic rocks of the Rhine, where these formations approach nearest to the trachytic character. But I must repeat, what I have formerly had occasion to remark, that the uncertainty of the characters of volcanic rocks is still so great, that a controversy about the name or class of a rock like that of Ischia is little better than a quarrel respecting words: the modes of formation and ejection are still obscure, and we are wholly in the dark as to the relative ages of most volcanic rocks, of which the most difficult seem to be those connected by infinitely fine shades of difference between Trachyte or Greystone, and the apparently sedimentary depositions of Pozzuolana, Trap, and Tufa. The essential characters of the tufa of Epomeo appear to be a homogeneous texture, rather fine in the grain, a powerful tendency to disintegration generally taking place in crusts, but the fracture of the massive rock is frequently conchoidal; alumina is an abundant component part, and the rock is soft and friable, with rather a smooth feel. It has occasionally an apparent stratified structure, and differs conspicuously from the tufas in the Bay of Naples in not generally containing fragments of lava or pumice. This seems to favour the views of Brocchi, Spallanzani, Breislak, and others who consider it to be a decomposed lava or trachyte. In this rock large felspar masses or crystals are sometimes found, and these are occasionally of a rose colour. Hornblende, is, I believe, also a production of the higher parts of the island. It is not unimportant, in judging of the nature of the aggregate rock, (as Dr Daubeny supposes it to be) to know that it is used along with lime as an excellent mortar: * this could not be the case were it a decomposed trachyte, and bespeaks the character of pozzuolana. The colour of this substance, we have already seen, is, at least on

* Siano, *Notizie dell'Isola d'Ischia*, § 48.

the north side of the island, characteristically green. This arises, Mr Scrope supposes, * from an admixture of chlorite, and this is extremely probable, since, as we shall soon see, aluminous and magnesian minerals particularly distinguish this island. Near the summit of the hill it assumes a more purely white colour.

Monte Epomeo rises to a considerable height above the sea: the common report is 1800 feet,—but unlike such reports generally, this is probably underrated; others have stated it at 2000 and upwards, and Tenore, in his lately published "*Essai sur la Geographie Physique et Botanique du Royaume de Naples*," assigns to it an elevation of near 3000 feet: this probably is too much, but I am disposed to think that it must exceed 2000. In the rocky mass which forms the extreme summit is excavated the dreary abode of two hermits, who reside here all the year. This cavern of Eolus, which is exposed to all the blasts of heaven, consists of numerous passages and chambers with several outlets, and contains a chapel. A path hewn in the rock conducts to the top, from whence one of the most splendid panoramic views of the Bay of Naples is enjoyed; but the morning on which I saw it was not very favourable. On the western side may be seen the distant islands of Santo Stefano, Ventotiene, and Ponza; the Monte Circello on the confines of the Pontine marshes, which is exactly sixty English miles distant; the point of Terracina, and the nearer one of Gaeta. Stretching round northwards, we may leisurely trace the marshes of Liternum, the place of exile of Scipio; the site of Cumæ, the lakes, the hills, the craters of the Phlegræan fields, and the indentures of their varied coast. The view is superior to that from the Camaldoli di Napoli, on account of the more beautiful intermixture of sea and land, and the more complete comprehension it conveys of the features of the Bay, the topography of the Cape of Miseno, the irregular form of Procida, and the commanding and very peculiar figure of the island of Capri, which rises to the eastward, beyond which the adjacent promontory of Minerva directs the eye to the rugged range of the Sorrentine

* *Geological Trans.* N. S. vol. ii. He also states that it may perhaps be owing to augite, (which he assigns as the cause in his work on *Volcanos*, p. 247,) but in my opinion this is much less probable.

hills, and carries it quite round to the noble cone of Vesuvius, relieved by the fine blue chain of the distant Apennines. Add to this the charming foreground which the spectator from Epomeo enjoys. Undoubtedly one of the most striking parts of the scene is the perfectly map-like configuration in which the beautiful island of Ischia lies stretched below him, as seen from this insulated point. The irregular trendings of its shores, the profusion of villages with which it is studded, and the rich mass of foliage which encompasses most of them, presents a picture both novel and delightful, and though situated at the extremity of the Bay, Epomeo undoubtedly affords one of its most admirable points of view.

Returning to the varieties of mineralogical structure which this great mass of tufa envelopes, the most important is the true or stony lava. Of this streams occur in various parts of the island, and several volcanic cones are formed of modifications of it. We have already described the stream which flowed from the *Campo del Arso*, and the others are almost equally sterile; they contain generally more felspars, which are grouped in masses containing crystals, sometimes two or three inches in length. Of the origin of these, mineralogists have much puzzled themselves, but we are obviously as yet quite ignorant of the causes of changes observed to be induced in many minerals under the action of heat. Much might be learned from what goes on frequently in our furnaces, and concretionary separations of component parts may be observed both in volcanic and trap rocks. The lavas of Ischia show no disposition to prismatic forms, and are entirely amorphous. Their mineralogical characters have been examined with minuteness by Spallanzani,* but are so much alike, that they need not long detain us. They are frequently porous, and abound in felspar, which appears to be in one form or other the most important component of the island; in some rarer cases the felspar is tinged red by oxide of iron, but more commonly the oxide is yellow, and confers its tint on a great part of the lavas. There can be no doubt that this substance is derived from magnetic iron ore imbedded in the solid mass, and which,

* *Travels*, i. 146, &c.

by disintegration, and the action of the waves, forms the magnetic sand which on some parts of the shore abounds, and which Spallanzani noticed to consist of octohedra or their fragments. A similar sand we have mentioned as occurring in the Bay of Pozzuoli, at the base of the Monte Olibano, which has, beyond doubt, a similar origin, and the lava of which nearly approximates to those of Ischia. So high does the felspathose character of the Ischian lavas sometimes reach, as to form beds of undoubted trachyte, which occur near Foria in huge masses, extending through the tufa. But the most remarkable locality is the Monte Taborre, between Casamicciola and Celso, which is composed of trachyte allied to clinkstone porphyry.* So much subterranean heat still exists here, that from the fissures of the rock watery vapours at a temperature of 49° R. = 142° F. still rise.† Of the age of the trachyte we have no historical data for judging, but, geologically considered, it overlies a bed of clay undoubtedly not older than the tertiary series, from the shells which it contains.‡

Not a few other craters, more or less distinct, appear upon the island, and in detecting them Breislak has shown his usual ingenuity; but it would be to little purpose to discuss them more minutely:—suffice it to say that we have some examples of cinereous cones resembling the Monte Nuovo.

Among the next most important volcanic products, though rather simple minerals than rocks, we must reckon the interesting substances of obsidian and pumice, which, though so different in appearance and structure, are intimately allied in their origin and composition. Both of these substances we have seen to be rare productions of Vesuvius, nor have we had occasion to mention the former in any part of the Phlegræan fields, except in the crater of Astroni;§ in Ischia it has been overlooked by many, or most authors, yet it occurs in considerable abundance in one part of the island, and its appearance is sufficiently remarkable to attract even the superficial observer. Dr Daubeny says, "At Castiglione the

* Daubeny *on Volcanos*, p. 181.

† Breislak, *Campanie*, ii. 224.

‡ Brocchi *C[illegible]ogia Subapennina*, Pp. 65 and 354.

§ See No. [illegible]*ices* in vol. x. of this *Journal*, p. 264.

ground is covered with loose fragments of pumice and obsidian, which I did not succeed in tracing to their source." Castiglione is situated between the town of Ischia (or Celso,) and Casamicciola, as the context implies, and it was indeed there that I myself met with large specimens of this substance, and was informed by my guide, (a native of the island,) that it was found in considerable quantity farther inland. With regard to its origin, the account of Spallanzani may give us full satisfaction, for in the English translation of the work of that able observer, *enamels* mean nothing else than obsidian, which he describes as being found in this spot in strata from an inch to a foot and a half or even two feet thick, accompanied by abundance of pumice, the whole being the distinct production of a crater in the neighbourhood named Rotaro, (which seems to be *Le Cremate* of some authors.) The pumice he describes as fibrous, occurring in large masses, and extending more than a mile. It is fitted for all the purposes of the pumice of commerce. Spallanzani justly says, that the eruption by which these were formed must have been of a slimy nature; the mass of obsidian which I examined, and which was of considerable size, had the most perfectly vitreous character, but was intersected by veins and striæ of clay, which had obviously once been of a plastic consistence, and the small specimen of it which I still possess displays the same structure. The explosion of the Rotaro must therefore have been accompanied with water in such quantity, as to have partly dissolved and carried along with it the strata of aluminous clay of this neighbourhood, which, as nearly as I remember, perfectly resembles the substance united with the volcanic products. It is not a little surprising that the obsidian of Ischia, a mineral so rare in the Bay of Naples, but here so abundant, should have been omitted by so many writers; even the minute Breislak seems to have passed it over, though so attentive to its rare occurrence elsewhere, as also a small work by Siano, expressly on this island, which professes to give an account of its mineral productions.

The substance we have next to notice is one which has been entirely overlooked by almost every writer, as far as regards its occurrence here, which is, I confess, attended with some

doubt, as to its position *in situ*, but only on that account offers the more curious field for inquiry. There are few strangers, perhaps, who have visited Naples without seeing the elegant snuff-boxes cut out of a substance termed there "lava d'Ischia," though probably a small number of them have thought of examining its nature, or inquiring into its connection with true lavas, and still fewer may have pursued their inquiry upon the island itself. This substance, strange as it may appear, is nothing else than precious serpentine. Whether this beautiful mineral, the undoubted concomitant of primitive strata, be really indigenous to the volcanic mass of the island of Ischia, is certainly a question worthy of inquiry. Yet though it is so familiar a substance at Naples, I have been able to find only one single allusion to its existence among the many standard and local works which I have consulted; and I fear that my own inquiries, though of some value, will not throw much light upon the subject, as, at the period of my visit, I was unaware of the full interest of the inquiry. It is in Brocchi's great work alone, upon the fossil conchology of the Subapennine range that I find this substance noticed. "On the shores of Ischia," says he, "are found fragments of this noble serpentine, which are cut at Naples into snuff-boxes, but we are not assured of its existence in the interior of the island; I am not sure but that these rolled masses may have been transported by the sea, or left by vessels which had used them for ballast."* Various reasons induce me to differ from this able Italian geologist, as far as my means of information of the occurrence of serpentine in Ischia extend. These I shall briefly state, without entering much into those hypotheses which would assume importance, could the existence of serpentine in Ischia as a locality be fully proved.

In the first place, then, I myself met with this serpentine in the interior of the island, in the bed of one of the small brooks which run down the north side of Epomeo. I own, however,

* I quote this important passage in the original: "Sulle spiaggie d'Ischia si trovano ciottoli di questa serpentina nobile che si lavorano in Napoli per farne tabacchiere; ma essa non esiste per certo nel intorno dell isola: ne so poi se quei massi rotolati sieno stati trasportati dal mare, o pure depositati dai vascelli che servissero di zavorra."—*Conchiologia Subapennina.* 4to. vol. i. p. 39.

that it was only a small rolled piece :—still its origin could not naturally be supposed to be from the coast. Perhaps, however, I shall neutralize this fact by stating another which candour requires me to mention. I picked up a fragment which I have no doubt was the same substance, (though I have now lost it,) on the shore of Sorrento, on the opposite side of the Bay of Naples. It would be easy to frame hypotheses for its occurrence there, such as that it was derived from the ornamental work of the temples and the villas of wealthy Romans, which formerly stood nearly on that spot, but I own that the circumstance is a presumptive argument for its accidental occurrence. But farther, I made particular inquiry of an intelligent guide in Ischia as to the mode of obtaining this substance, with which he was well acquainted, and his communications certainly never led me to believe that its occurrence was limited to the coast, or most abundant there. I rather carried away the impression that it was found in small quantity on the eastern side of the island, above the town of Ischia, but that the principal sources having been exhausted, it was daily becoming scarcer, and now rarely met with. Nor did he appear at all surprised at the locality in which the rolled piece, already alluded to, was found at a great distance from the sea. The hypothesis of being transported by the sea, and by vessels as ballast, seem equally improbable. Why, in the former case, should it have been thrown in comparatively great abundance on the Ischian coast, and on the neighbouring ones rarely, or generally speaking, not at all. And in the latter we should be much disposed to question how so large a quantity of this beautiful substance (and none know better than the Italians the value of serpentine and its allied minerals,) should, beyond the memory of tradition, come to be diffused over the shores of Ischia, not to ask where this beautiful substance was obtained ; for most of the esteemed green ornamental stones of Italy are not noble serpentine, but Diallage and Saussurite. But it might be asked, if these suppositions are to be abandoned, do the known facts connected with the constitution and productions of the island warrant the opinion that it *could* be there found *in situ ?* I answer, that in many respects they do : and first, as to its connection with volcanic rocks ; next as to the

particular substances admitted to exist on the island, and with which it must be in connection.

Serpentine at present is one of the most undetermined members of our geological arrangement. Dr Macculloch, in his work on the classification of rocks, has admitted the difficulties attendant on its phenomena, and has indeed altered in the last sheet, the views which he had given on the subject in the middle of the book; but its connection with trap rocks, in some situations at least, is undoubted. He mentions two instances in which a vein of greenstone, rising through secondary limestone, (qu. of the magnesian variety?) on coming into contact with that rock, assumed the characters of perfect serpentine, containing the characteristic minerals of asbestus and steatite, with talc on its margin next the limestone, and the vein exhibited the most perfect gradation from the trap into the serpentine.* He has also observed the intimate connection of serpentine with hornblende rock in the primitive strata. I have myself studied one of the most important phenomena connected with this question, in Inch Colm, an island in the Forth, where secondary greenstone, secondary syenite, and secondary serpentine, containing well defined asbestus and talcose matter, are most instructively combined. A dyke of serpentine in Forfarshire, led Mr Lyell to the conclusion of the igneous origin of this rock, † and Dr Bouè has observed similar facts on the continent; ‡ he has distinctly arranged serpentine in his classification, under "unstratified crystalline or igneous rocks." || At the present day, little is required to enforce the similiarity of substances connected with trap rocks and those of volcanos. But lest it should be thought that the union of serpentine with true volcanic rocks is not a necessary consequence from the analogy of trap, we may add, that Sir George Mackenzie, in his work on Iceland, gives an account of a volcanic amygdaloid, in the mountain of Akkrefell, traversed by veins of serpentine of more than a yard in thickness. Ferber considered, and it would appear not without great reason, so far as external cha-

* *Classification of Rocks*, p. 245.
† *Geological Transactions.*
‡ Dau[illegible] *Volcanos*, p. 430.
|| *Ed*[illegible] xiii. 132.

racter goes, the serpentine rocks at Monte Traverso, not far from the famous gaseous exhalation at Pietra Mala in the central Apennines, as decidedly volcanic; and Guettard discovered serpentine in what he considered volcanic formations between Rome and Loretto.* Faujas de St Fond † mentions a lava in the volcanic district of Auvergne, which, from his description, must undoubtedly be considered as nearly allied to serpentine, and which he characterizes as "compacte argilleuse, d'un verd tendre, savoneuse, et repandant une forte odeur terreuse lorsque on souffle dessus." We may add, that Count Borch, when examining the serpentines of Sicily, was, notwithstanding the backwardness of mineralogy at that period, led to suspect their igneous origin. ‡

But besides, we have several reasons for inferring that serpentine might be *in situ* in Ischia, from the minerals with which we should have found it associated. We find that in one of its most famed localities in the neighbourhood of Florence, it accompanies a marly clay of the same characters as that we are about to describe near Casamicciola in Ischia. It is according to Ferber bluish grey or yellowish, which furnishes the best materials to the potters of Impruneta for their manufacture, becoming of a reddish colour in the fire. It is accompanied with sulphate of lime, and from the structure apparently approaching sometimes to that of steatite, Ferber conjectures that it may have had some part in its formation. § Now, in Ischia, the clay in which I conjecture the serpentine to have been imbedded, has all the characters just mentioned. It is besides, accompanied with steatite, ‖ and the springs which issue from it contain sulphate of lime, ¶ so that if we can conceive the natural formation of noble serpentine in such a spot, we have a very fit matrix prepared for it. But even if we should not be disposed to admit its presence as an indigenous rock, it may at least have been elevated by volcanic explosion

* Ferber's *Travels*, 282, *&c.*
† *Mineralogie des Volcans*, p. 394.
‡ *Mineralogie Sicilienne*, 8vo. Turin 1780. p. 140.
§ *Travels*, 275.
‖ Siano, *Notizie d'Ischia*, § 49.
¶ Andria, *Tratato delle acque Minerali*, ii. 175.

from the deep-seated bases of Apennines, which in different parts, as Lombardy, Tuscany, Calabria, and Sicily, display this rock in remarkable perfection.* But it is undoubtedly a mistake which seems to have sometimes prevailed, that magnesian minerals are in any way inconsistent with a volcanic origin. Steatite, which is most intimately allied to serpentine, is not unfrequently found in such formations, and olivine, the very volcanic crysolite itself, is a magnesian mineral. I fear I have extended too far these observations on the Ischian serpentine, but I consider the subject to be one of great interest at the present moment. I will only add, that these masses of noble serpentine, whatever be their origin, have an uncommonly fine mineralogical character: when cut thin (as they always are for ornamental purposes) they are very transparent, and show a beautifully variegated structure, with nearly black clouds on a fine deep grass green ground; it yields to the nail as usual.

The substance we have next to notice, and which is one of the most characteristic productions of Ischia, is the peculiar clay just alluded to. Great beds of this substance exist at the north-eastern part of the island, and it was as much used by the ancients as now for the manufacture of pottery, from whence indeed, according to Pliny, the island took its name.† I regret that I have no analysis to offer of this earth. Breislak,‡ however, tells us that it consists of alumina, silica, a little magnesia and less lime. It abounds near Casamicciola, and was dug out by means of subterranean pits, being not merely used on the island, but exported for the purposes of manufacture. Its close analogy to the materials used in constructing the Etruscan vases, may be argued from the following analysis of these by Vauquelin: silica 53, alumina 15, lime 8, oxide of iron 24.§ The Ischian bed of clay underlies the trachyte of Monte Taborre, and from the shells which it contains, must,

* Brongniart has given a very full account of the Serpentines and Diallage of Italy, in the *Annales des Mines* for 1821. It is translated in Mr De La Beche's excellent volume of Foreign Geological Memoirs.

† Pithecusa, Plin iii. 5.

‡ *Campanie*, ii. 208.

§ Hausmann on the Etruscan vases, *Ed. Phil. Journ.* xiii. 46. Perhaps the iron was derived from a mixtnre of Pozzuolana.

as we have already remarked, be at least as recent as the tertiary series. It is called Creta on the island.

This clay must be carefully distinguished from the "pietra aluminosa" or alum rock. The latter seems at one period to have been very abundant, and actually to have given rise to the first alum-work in Italy, though now so entirely superseded by that of Tolfa in the Roman states, to the rock of which it bears much resemblance. It was first wrought by one Bartolemeo Pernix, in 1459, and was continued for a considerable time, and it is not even known why it was given up, but probably from the increasing scarcity of the rock which is now found only in insulated masses on the north side of Monte Epomeo. Breislak characterizes the aluminous rock as a lava in a state of decomposition, but I am more disposed to consider it as real alum slate elevated from below; probably the great abundance and plasticity of the clay is connected with the occurrence of this "pietra aluminosa." Remains of the ancient alum-works exist at the spot called the "Piazza della Pera," but there the material seems to be exhausted.

We must not confound either of these substances with that named "Terra d' Ischia," which is merely an extremely fine pozzuolana, which is much esteemed as a cement in nice operations, such as ornamental pavements.

The occurrence of gold in Ischia has been repeatedly asserted, but the report has been apparently derived solely from the authority of Strabo, who seems to have stated it merely from the report that the Erythræans wrought that precious metal when they were in possession of the island. But though no gold be now found, and although the whole may probably have arisen in a mistake, there is no need for ridiculing the idea, as some have done, as utterly absurd. Gold is not so unknown in volcanic districts, as Andria asserts,* and is even there found in abundance, in one instance at least on record.† We have likewise had occasion to mention the belief which was long entertained of its occurrence in this very neighbourhood, namely in Vesuvius itself.‡ With respect to Ischia, however,

* *Acque Minerali*, ii. 67.

† Breislak, ii. 188.

‡ See this *Journal*, vol ix. p. 206. and x. 136.

it can hardly be doubted that, now at least, it does not there exist.

Ischia is more celebrated for nothing than its hot baths, which are much esteemed by native physicians, as are also those steam-baths technically called "Stufe" or *stoves*, which here abound. Italian authors dwell with peculiar satisfaction on these topics, which are, I must say, peculiarly dull to most readers; I shall therefore pass over the mere descriptive part with more than usual brevity. Most of the mineral waters evolve carbonic acid, and some of them sulphuretted hydrogen. The mineral contents have not, so far as I know, been accurately stated, but the following are nearly the proportions in one of the most remarkable springs, to which I shall chiefly confine my remarks, the Gurgitello near Casamicciola. Its solid contents are to the water as 1 : 221.5, or about a-half per cent.* They are approximately composed of

Muriate of Soda - -	77
Muriate of Lime - -	15
Sulphate of Lime -	5
Sulphate of Alumina -	3
	100

This spring flows from the bed of clay described above under the name of Creta, and from it the water appears to derive its solid ingredients. The temperature of this spring, as given by Siano and Andria, is 50° R. = 144½ Fahr.; by Breislak 46° R. = 135½ F. I observed it on the 28th of March 1827, to be 149° F. and a smaller stream running neglected from the alluvial matter at a considerable distance and nearer the mountain 144.5. This is by no means the warmest spring in Ischia. Siano assures us, that in one, named Le Petrelle, the thermometer rises to the boiling point. Another is mentioned by Hamilton, as having a temperature of 70° R. = 189½ F. Others occur of a variety of lower temperatures, and they are distributed along the base of Monte Epomeo at considerable distances, and in various parts of the island. All these are striking proofs of the preeminence which Ischia holds among partially extinct volcanic districts, in its vicinity to sources of in-

* Andria.

ternal heat. Down to the very shore its influence extends, and the sands of Vico, at two feet below the surface, have a temperature of 110° F. *

The "Fumarole" or emissaries of aqueous vapour, of a high temperature and elastic condition, are also numerous and remarkable. They rise through the fissures of lava beds, and, what is most interesting, they produce siliceous incrustations of a nature similar to those of the Geyser in Iceland. This phenomenon was first observed by Dr Thompson of Naples, in 1795 at Monticeto, where the vapour had a temperature of 75.5° R. = 202° Fahr. To this substance he has given the name of Fiorite, from Santa Fiora in Tuscany, † where it was discovered by Professor Santi of Pisa. In 1794, Thompson established its occurrence in the lavas of Vesuvius. The *fumarole* of Monticeto in Ischia, deposit sulphates of lime, alumina, and magnesia, and as these appear to result from the action of a small quantity of sulphuric acid evolved upon the components of the lava, the silica which that rock contained seems likewise to have become the subject of real chemical action, and is not merely deposited it dull crusts upon the tufas thus formed, but in vermicular and botryoidal forms, with vitreous fracture and considerable hardness and transparency. This mineral, which differs slightly from the siliceous sinter of Iceland in having frequently a pearly lustre, is chiefly found in Italy,—the Bay of Naples, Tuscany, and the Vicentine, being its principal localities. In its origin and important characters, it is closely assimulated to the productions of the Geysers and of the volcanic districts of Teneriffe and Lanzerote, as observed by Humboldt and Von Buch; and the singular phenomenon of its solution in water must be explained in all by the same cause. We know that silica is minutely soluble in water in its ordinary condition, and the experiments of Berzelius lead us to believe that in its newly formed state it is very considerably so; but the main agent is undoubtedly the presence of an alkali, which here we have seen is not awanting, for the clays of Ischia and likewise its mineral springs contain it in considerable abundance. It is here soda as in Iceland, where

* Daubeny.

† Not in Ischia as Philips says: *Mineralogy*, Art. *Fiorite*.

the memorable experiments of Black demonstrated the existence of 16 per cent. of that alkali in the siliceous compound. The remarkable effect of this substance in promoting the solution of silica in a state of fine division of parts, and especially at high temperatures, sufficiently explains why these depositions should be entirely confined to countries now or formerly under the action of volcanos.

Other parts of Ischia present specimens of the same substance. In the extinct crater of Canali, Breislak found a mass incrusted with a stalactitic siliceous crust to the thickness of three lines. * Besides, at Vesuvius it occurs in the rock of the Solfatara, and in the tufa at its base; in the latter, Dr Thompson was able to discover some of the triangular facettes of the six-sided pyramid. It is also met with at Astroni. The only example, as far as I know, of the detection of silica as a constituent in the water of a spring in the Bay of Naples, is in the Gurgitello above described. Tenore † claims the honour of this discovery, made by him in 1801, and since disputed. It was not, however, published till 1816. Some of the mineral contents of the spring are said to exist in the state of *bisilicates*.

One other fact connected with the island of Ischia, and that a very interesting one, we have alone to notice. Near Lacco, on the north side of the island, is a grotto or cavern, formed of loose blocks of lava, from which issues constantly a cold wind, which seems first to have been observed by Saussure. He found the temperature of the stream of air in March 1773 to be 45.°5 Fahr., the external air being 63.°5. ‡ He adds, that he was told that it was greatly colder in summer; but it is hardly necessary to observe, that this mistake is in similar circumstances constantly repeated by those who judge only by their feelings. And as we might suppose, it appears to be much the reverse, for Breislak observed the temperature of the cavern to be 13 R. = 61¼°. F. when that of the air was 21 R. = 79¼°. F. § The difference of temperature in both

* Vol. ii. p. 215.

† *Essai sur la Geographie Physique du Royaume de Naples*, p. 28.

‡ Saussure, *Voyages dans les Alpes*, § 1414.

§ *Campanie*, ii. 214.

these cases is *precisely eighteen degrees.* Certainly the phenomena of the ice caves of the Alps and the cool grottoes of Italy require much elucidation, and in the still imperfect state of hygrometric science it is difficult to maintain or disprove decisively any hypothesis. My own opinion is, that evaporation in some form or other will be found to be almost the sole cause,—an opinion which I have long entertained, and which some years ago I endeavoured to support * even in the very extreme case of Saussure's experiment at the Monte Testaccio at Rome. Since writing that paper, I have indeed seen more clearly the great discrepancies between authors on the subject of hygrometry; and it is not till I shall have found leisure to investigate it more completely that I shall be able to offer any decisive opinion. Meanwhile, however, no other theory but that of evaporation seems feasible; the hypothesis of Dr Anderson, that cold air is conveyed by crevices from mountains of such a height that the mean temperature does not exceed that of the cold stream observed, is not merely inapplicable to the Monte Testaccio but also to the present instance. I have elsewhere shown that the mean temperature of the summit of Epomeo cannot be below 56°, yet in the month of March, when the atmosphere had rather more than its mean temperature, Saussure observed the grotto to be so cold as 45°. Yet after all, the phenomena of the cavern at Lacco if taken singly, might be sufficiently well explained by the known facts of evaporation. It is somewhat remarkable that the coolness observed by Breislak near the extreme summer heat was almost precisely that of the mean temperature of the place. On the theory of Saussure, therefore, that there are spacious caverns in the earth which never exceed in temperature the mean of the place, we need have no recourse to the theory of evaporation, though, in my mind, a far more natural supposition would be the free passage of ventilation through the loose materials of an extensive mass, and therefore exposed to the influence of evaporation, which, on the supposition of confined and of course damp caverns, could have no place. This is also confirmed by the apparent constancy of the difference

* In a paper published in this *Journal*, vol. viii. p. 205-216.

of temperature in spring and summer; and the refrigeration of 18° in both cases is no very extreme supposition. *

I forbear to enlarge farther upon a topic so confessedly obscure, and which, I conceive, may at some future time be reduced to practical accuracy. For the present, I content myself with referring to the paper on the much more unaccountable phenomena of the Monte Testaccio, the details of which will, I think, satisfy the reader that, by the hypothesis there supported, all other cases on record will easily be solved, including the "Grotta del Vento" in Ischia.

ART. XXIII.—HISTORY OF MECHANICAL INVENTIONS AND OF PROCESSES AND MATERIALS USED IN THE FINE AND USEFUL ARTS.

1. *Notice of the Rock Crystal Watch of M. Rebillier.* From a Report to the Institute, by MM. PRONY and NAVIER.

M. REBILLIER does not propose to introduce any improvement into the art of watch-making; but his work is distinguished by the nature of the materials employed, and by the difficulty, the delicacy, and the perfection of the workmanship. This watch, whose dimensions are so small that it may be worn round a lady's neck, is almost entirely executed in *rock crystal.* The transparency of the substance allows us to see the interior mechanism of it. The two toothed wheels which conduct the hands are in *rock crystal*; the other wheels are in metal, to prevent the accidents which would arise from the breaking of the main spring. All the screws are cut in the crystal, and all the pivots turn in *ruby* holes. The bridge and the piece which form the escapement are in sapphire, the balance is in *rock crystal,* and the spiral spring in gold. The author ascribes to the feeble dilatation of these two substances the regularity of the motion of the watch; † but this

* Humboldt, in describing the Peak of Teneriffe, has made some remarks on the theory of ice caves, but they are less applicable to merely cool currents of air.—*Personal Narrative,* i. 154.

† In November 1824, Dr Brewster proposed to construct the balances of

remark is not justly applicable to gold, whose dilatation is greater than that of steel. It is easy to conceive the difficulties which must be encountered in executing out of the hardest stones the delicate pieces which enter into the composition of a watch like this. The execution of this watch presupposes a remarkable progress in the art of working precious stones, and we must give M. Rebillier credit for great talent, address, and perseverance.

2. *Account of Dr Ranken's Thermantidote for cooling apartments in hot climates.*

The *thermantidote* is a species of ventilator which has been not inaptly compared to a winnowing machine, the revolving of which sucks in air from without. The improvements in the thermantidote consist in its being altogether rendered less complex in its structure, and more easily manageable by native servants, so as at the time to increase the ventilating and cooling power. We cannot without the aid of a figure make the alterations and details of the machine comprehensible to the general reader; suffice it to say, however, that after the improved mode of construction, the wings of the thermantidote will revolve sixty times in the minute, under the same exertion which, on the old plan, would produce only forty revolutions in the same time. The alteration suggested may be made by an ordinary carpenter at very little expence. Dr Ranken has also studied to render the machine much more portable than it was before; which will render it particularly convenient for cooling tents, which many have to live in during the hot winds. His belief also remains unchanged, that a barrack, or any large apartment, can be more effectually and cheaply cooled by ventilators on the improved thermantidote principle, than by tatties. It should at the same time be borne in mind, that thermantidotes may not be found applicable to every place built originally without the contemplation of their use, unless certain alterations be made. They appear to act

chronometers of rock crystal, to avoid contraction and dilatation, and the magnetic effects produced by metallic balances. Pendulum rods, with pendulum springs of mica, have for several years been under trial in Edinburgh, and succeed beyond expectation.—Ed.

to most advantage when placed high over a space not exceeding sixty feet by twenty. "Air becoming specifically heavier by being cooled, like every substance having weight, is projected farther from an elevation than along a level surface; and in the supposed (elevated) situation, it would keep supplanting what is constantly getting heated by contact with the occupants, just as water when poured into the same vessel is seen to displace spirit." One engine, requiring a single workman at a time, would suffice for an apartment of the dimensions mentioned; but Dr Ranken suggests that two should be employed, facing in contrary directions, that either may be resorted to when unmanageable draught stops the other. This machine has been found so useful in allaying the heat up the country, that it is, we understand, coming into more general use than might have been supposed, considering the slowness with which people adopt new inventions, however beneficial they may promise to become.—From *Asiatic Journal*, vol. xxviii. p. 323.

3. *Chinese mode of making Vermilion.*

Take quicksilver and sulphur, in the proportion of sixteen taels of the former to four of the latter; after powdering the sulphur place them in an earthen jar, the outside of which must be plastered with mud and salt to the thickness of three inches and a half; place an iron cover on the mouth of the jar, and let it be kept constantly moist. Plaster the sides of it so as to let there be no passage for air. Then place the jar in an oven, with 120 catties of charcoal. Let this be done early in the morning, and the next morning about the same hour extinguish the fire, and at noon take it out of the oven, and when cold break the jar in pieces, and take out the contents. Pick out the dross, and then reduce the rest to a fine powder. Let this be poured into a large jar full of water. After a time a thin coating is found on the surface of the water, which is carefully skimmed off, and a portion of the water let off; after a time this operation is repeated, the third time all the water is drained off, and the sediment is then exposed to dry, and afterwards taken out in cakes. This last portion of the vermilion is called "the heart of vermilion."—From *Asiatic Journal*, vol. xxviii. p. 326.

4. *Chinese Mode of making Indigo.*

Immerse fifty catties of indigo leaves in a vat of clear water, let them be washed clean, and exposed to the air, after which let them be steeped in water for twenty-four hours. A small jar of burnt shell ashes must then be added, and the whole stirred up with a bamboo. Clear off the scum, and throw in half a catty of the powder of burnt ox-hide; mix these, and let them settle, and when the surface of the water becomes transparent let it off, and expose the sediment which remains to the open air; if rainy weather render this impracticable let a charcoal fire be kindled round the vat. When dry the indigo may be taken out, when it is fit for immediate use. The above quantity should yield upwards of two catties of indigo.—From *Asiatic Journal*, vol. xxviii. p. 326.

5. *Account of the preparation of Oleocere or a wax for candles from Castor oil.* By Mr J. Tytler.

Nine years ago the following passage, from *Brande's Manual of Chemistry*, suggested to Mr Tytler a course of experiment on the product forming the subject of his paper, *viz.* "nitric acid, heated in small quantity with any of the fatty substances, renders them harder, and considerably increases their solubility in alcohol. Among the vegetable oils, this change is most remarkably produced upon coco-nut and castor oils, the latter becoming converted into a solid matter, which, when cleansed of adhering acid by washing, resembles soft wax."

On reading this, it occurred to Mr Tytler that oil so consolidated might have sufficient firmness to form a candle. After a few necessary rude experiments, Mr Tytler adopted an improved mode of preparing what he calls oleocere, the great object being to keep up a uniform heat, and preventing too high a degree of temperature. He thus describes the process: "I therefore made water boil in a large fish kettle, and mixed a quantity of castor oil and nitric acid in one of those China jars which are employed to hold preserves. Then carefully stopping the mouth to prevent the entrance of vapour, I placed this in the boiling water, and kept the whole upon the fire for about an hour, after which I took it off, and set it by to cool. The effect even exceeded my expectation. It har-

dened into an uniform mass of no disagreeable colour, and of very tolerable consistency. After a certain number of trials, experience taught me that the best proportion for mingling the substances was eighty parts of oil to one of strong fuming nitric acid, and having increased my apparatus, I continued with this receipt to prepare a considerable number of candles, which answered their purpose sufficiently well.

By degrees, however, he began to experience unaccountable variations in the process; for in spite of all his pains, the oleocere sometimes would not harden, but continue unalterably of the consistence of butter. For a long time he concluded these defects to proceed either from the entrance of watery vapour into the jars whilst boiling, or from the increasing heat of the weather at the time. To remedy this he took every precaution in shutting the jars, and when the process was over, placed them behind a tattie to cool. Still this was to no advantage, and many trials showed that the hardening of the oleocere was a matter of the greatest uncertainty.

Some time afterwards, being placed in more favourable circumstances for conducting his experiments, he adopted another plan, which we give in his own words: "I erected a furnace about four feet from the ground; on this was placed a large iron boiler to serve as a reservoir; immediately adjacent to this first furnace, was built another furnace about half the height of the former, on which was placed a round iron vessel whose side was about ten inches high, and whose capacity was such as to contain seven of the China jars already mentioned. In the side, about two inches below the level of the top of the jars, was fixed a pipe, so that the water might rise to this level and no more, whatever should be superfluous being carried off by the pipe. Having then a quantity of water to boil both in the reservoir on the copper furnace, and in the vessel on the lower, and having prepared a long copper syphon, I placed its short leg in the reservoir, and directed its long leg to the lower vessel, so that a perpetual stream of water should be conveyed from the upper receptacle to the lower. By this contrivance, the water was perpetually kept boiling, and the quantity in the lower vessel was uniform,—its loss was perpetually supplied by the syphon, and its excess carried off by

the pipe. There were placed seven of the China jars, with eighty parts of oil and one of acid. After boiling thus for an hour, they were taken out, seven more placed in their room, and so on for a third time."

We have been thus particular in describing the process, in the hope that those who have plenty of time and opportunity may repeat Mr Tytler's experiments, with the view, if possible, of bringing the product to perfection, and rendering it generally useful in those parts where castor-oil abounds, but where wax may not be equally procurable and cheap. After all, however, perhaps the most eligible and economical plan will be found to be using the oil simply for the lamp, instead of converting it into oleocere.

Mr Tytler found that dropping the oleocere from a height on the floor hardened it. He submitted a specimen of the substance to the meeting, which was harder and brighter than what is commonly obtained, but still too soft to form candles for burning in the hot weather; and notwithstanding his laudable perseverance and great trouble, Mr Tytler does not appear sanguine as to the substance being very likely to prove useful as a substitute for wax in making candles.

The oleocere of coco-nut oil, prepared in the same way as that of castor-oil, he found never hardened beyond the consistence of butter; its colour was paler, and it might perhaps enter advantageously into the composition of ointments.—From *Asiatic Journal*, No. i. New Series, p. 66–67.

Art. XXIV.—ANALYSIS OF SCIENTIFIC BOOKS AND MEMOIRS.

I. *The Article* Ship-Building. Published in Vol. xviii. Part I. of the *Edinburgh Encyclopædia*. Edited by Dr Brewster. Continued from page 171.

All the cultivators of ship-building previous to our own time, must have been constantly subjected to the mortification of finding the figures assigned to the vessels which they constructed, and on whose lines they had probably bestowed much meditation and care, undergo considerable changes the moment the vessel entered the water,—its natural element, and where it ought to retain the exact form originally assigned to it. The plane of flotation, on which the genius of a Bouguer may have dwelt, and which

has had high and transcendental curves applied to its different parts, may have had all its properties altered the moment the vessel was launched. The beams imperfectly attached by their ends to the sides of the ship would occasion transverse alterations of form; and the unequal action of the pressure and the weight producing, by tagging or hogging, those great alterations of form longitudinally, which in many instances have obtained for our men-of-war the epithet of *broken-backed*. Most of our readers are aware, that, in the ordinary constructions of carpentry, the figure at first devised by the workmen is not often ultimately attained. In the commonest roof, what difficulties seem to be in the way to meet the action of gravitation on the timbers, and the diversified strains produced by its power! It is one thing to join together a system of timbers, and another to estimate the best form of their combination. It is not always the *quantity* of material that may be employed in a mechanical construction which imparts to it strength, but the *disposition* of its component parts. Ten load of timber in the hands of Seppings would produce a resultant having greater mechanical advantages, than twenty employed by some of his predecessors. Some men imagine that strength is only to be gained by the employment of heavy masses, not considering that the nature and quantity of the strains acting on them may entirely disturb their arrangement. We remember an English squire once endeavouring to persuade us that the gates of *his* county were the best, because they were rectangular filled with *vertical* bars, and incapable of being resolved into any form but that mentioned. The notion of a triangular combination of timbers, and of the invariable form which such a combination preserves, was unknown to him. The strength was obtained, so said this rich agriculturist, by the *parallel* bars, and the efficacy of one in a diagonal direction was gravely doubted. At that time, however, neither the Royal Institution, Mechanics Institutes, or the Society for the Encouragement of the Useful Arts, existed. Men combined together timbers, but without inquiring after the legitimate laws on which all such combinations should be founded. Sir Robert Seppings found our dock-yards much in the same way. One generation of shipwrights had succeeded to another, and each was content with the labours of its predecessor. Timber in abundance was supplied by the liberal grants of Parliament, but science had little to do with its consumption. Forests were levelled to satisfy the demands of a vigorous and long and protracted war; and the lofty bends of timber which constituted the frames of the ships which conquered Copenhagen and the Nile, were, like the country squire's gate, disposed in enormous *parallel* arrangements bearing imperfectly on each other, and deriving a large proportion of their support from the planking alone. Here then was a field open for the ardent enterprize of some one capable of surveying the mighty fabric of a ship in all its complicated relations;—some one whose mind was freed from the uncertain rules that guided his forefathers, who could contemplate the whole with the eye of a mechanical philosopher, apply to it all the beautiful relations of strain, pressure, and force, and courage, to withstand all the opposition which such a great innovation must necessarily raise. The rectangular disposition of the timbers hence gave way to oblique braces and riders

placed nearly in the directions of the diagonals of the squares formed by the frames and planking of the ship,—thus resolving the whole into forms incapable of change, and imparting to the mighty and gigantic frame a degree of strength and firmness never before found.

The author of the paper has described with great minuteness the leading elements of this important system of mechanical construction, and we regret that our limits will not permit us to detail them; but we cannot omit adverting, though but briefly, to the great improvement of Seppings in making the timbers originally employed for sloops of war applicable for frigates, and the timbers for frigates to ships of the line; thus proving satisfactorily, that a well combined number of small timbers may be equal, if not superior in strength, to the overgrown and frequently grain cut materials formerly employed in our large ships of war. No one more than Seppings has more successfully employed the admirable maxim of the late lamented Tredgold, "that a just economy of materials should be one of the first objects of the builder's attention, and this desirable end is to be obtained only by judicious combinations of the materials to be used."

On the question of the sterns of vessels,—a fertile subject of debate among our noble and gallant seamen, some excellent observations are added by the author of the paper. We wish, however, he had attended to the fighting powers of the bow. Why the stern alone is to have its powers of offence and defence increased, and the bow to remain the same, we confess we can see no reason for. In truth, from our rivals on the ocean having adopted our improvements in the stern, the strength of *our* bows is virtually diminished. An increment to the power of the stern absolutely becomes a *decrement* to that of the bow, because our ships, in by far the majority of cases, are the pursuers. But what, we would ask, is the obstacle in the way of strengthening the bow? We do not mean its mechanical strength, but its capabilities of fighting. Why is so much eloquence and ingenuity bestowed upon the stern alone? Why are we to be tormented everlastingly with dissertations upon its increased strength, the absence of a point of impunity, and the power it possesses of having a gun to bear every where round the circuit of the stern? The absence of all attempts on the strengthening of the bow is a defect in the paper. An attempt, indeed, has been lately made by a Mr Blake at Portsmouth, to improve the fighting powers of the bow, and we hear that the experiment is to be tried on the Vindictive; but, from what we have seen of the plan, we are not very sanguine as to the result. A wide area of improvement is therefore open, and we shall rejoice to see it entered by some one. It is an improvement also, which will be found much more in unison with the active feelings of our seamen than the change—a beneficial one unquestionably, which the stern has undergone. Let us not, however, be misunderstood. We are highly pleased with the later alterations Sir Robert Seppings has made in the stern, and we admire the eloquence with which Mr Harvey has defended them; but we wish to know why the bow has been abandoned? why its offensive powers have not been increased as well as the stern? We are persuaded that a very material improvement might be made, and we earnestly hope our naval architects will not lose sight of it.

But we must hasten to the last branch of this interesting and copious paper on the Application of Steam to the purposes of Navigation,—an application unquestionably destined to impart a new character to naval warfare. In a calm, a steam-ship, as the author properly remarks, must possess a decided superiority over an opponent navigated by sails; and hence battles that formerly remained undecided on account of the wind, would, had the power of steam then been known, have been entirely accomplished. Coasts, rivers, and harbours also, that were considered as secure by the old plan, will, by this new application of vapour, be assailed and defended by it. The system of warfare will thus be entirely altered, and perhaps the steam-gun will aid the work of human destruction. A modification of its energies, as our author beautifully observes, will, however, assist the milder and more beneficent purposes of commerce, and direct the steps of civilization into regions now debased by gloom and superstition. Thus it is that art as well as nature tends to an equilibrium in all its operations. If the application of steam to the purposes of war seems likely to increase the sum of human calamity, so will the sum of human happiness be augmented by the impulse it will communicate to the whole social system.

We are exceedingly glad to see that the author of the paper unequivocally admits Jonathan Hull as the first inventor of the steam-boat, and that to Great Britain the invention is due both in theory and practice. He does full justice, however, to the merits of Mr Fulton.

Some of our readers perhaps remember, that our neighbours, the French, anxious to know every thing respecting the construction of steam-vessels, sent Marestier to North America to report on the steam navigation of that country. Much of the important matter of that report is brought before us in the article under consideration. Copious tables of the length, breadth, and draught of water of the American steam-boats are given; the positions also of their paddle-wheels; the relation between the dimensions of a vessel and the power of its engine; the comparative proportions and velocities of steam-boats; the resistance of their hulls; the equivalent action of the paddles on the water, and the steam on the piston; the effects of friction, &c., for the able disquisitions on which we must refer to the article. Marestier's rule, however, for finding the velocity of a steam-boat, may not be unacceptable to our readers in this age of steam.

The velocity of a steam-boat may be found by extracting the cube root of the product of the following quantities: The altitude of the column of mercury the steam will support, the square of the diameter of the piston, the length of its stroke, and the number of times it is raised in a minute, and dividing the result by the cube root of the product of the breadth of the vessel into its draught of water, the final result being multiplied by the constant coefficient 2.53. The application of this rule to nine of the American steamers gave an error of less than $\frac{1}{10}$th of the actual value.

Marestier objects to the method commonly employed of estimating the power of a steam-engine by the number of horses. His rule is: *Multiply the height of the column of mercury the steam will support by the square of the diameter of the cylinder, and the mean velocity of the piston; sixty-six*

and two-thirds of this product will be the number representing the horse-power. Then will the velocity be equal to twice the cube root of the quotient of the number of horses, divided by the rectangle of the draught of water and the breadth of the vessel.

His general results are important, and are as follows:—*To stem a current with the least consumption of fuel, the absolute velocity of the vessel should be only half the velocity of the steam. That the velocity resulting from the use of the rope and roller is greater than that which results from the use of the paddle-wheel, in the proportion of the cube root of the velocity communicated by the paddles to the vessel: That to enable a vessel to stem a current with an absolute velocity equal to half the velocity of the current, it requires three times the motive power, if that power acts on board the vessel, that would be necessary if the power were applied to the rope: That when the current is rapid, it is advantageous to use the rope for hauling, in order to stem it; but that, if the current is not strong, it is preferable to use the paddles; and that the paddles should always be used in descending a stream, when the absolute velocity of the vessel is greater than the velocity of the paddles, or when the velocity of the stream is greater than the velocity with which the paddles strike the water, which will generally be the case.*

Much doubtless remains to be done to perfect the theory and practice of steam-boats; yet in an invention, comparatively so new, it is remarkable how rapid have been the steps already made in their improvement. Bernouilli was a man who looked at things largely—one of those chosen ministers of nature, destined in a thousand instances to enlarge her transcendant domain;—yet he thought, only fifty years before the great triumph of steam, that this peculiar application of it was impracticable. How would it delight his ardent and magnificent mind could he now behold its lofty achievements—its varied and increasing powers—the voyages it has accomplished over the stormy bosom of the Atlantic, and how it has connected the busy stream of the Thames with the mighty waters of the Ganges?

Much interesting and important matter now remains to be noticed, notwithstanding the copious length of our analysis,—so wide is the dominion of naval architecture, and so fertile every part of its soil. Let us hope that the spirit which is now awakened respecting it may carry it onwards to the glory and perfection it merits;—that the wooden walls of Old England may obtain whatever advantages the other sciences can impart to it. In the meantime, let the humblest shipwright learn that his country has a claim on the successful application of his powers to perfect the art to which his whole life is to be devoted, and that the noble fabric which his hands has assisted to rear, requires the exercise of his noblest intellectual powers to make it perfect and complete.

Finally, we conclude with the author of the paper by saying, that it is not in the terrible season of war, when the hopes and energies of man are principally occupied with conquest, that naval architecture can be expected to make its greatest steps towards perfection. In war, as Dupin observes, the object is to do much in a little time, to sacrifice rigorous methods to means ready and expeditious, and the way, the best in itself, to

the manner most commonly known. At the return of peace, and when a nation begins to feel the benefit of repose, opportunity is offered for reflection, and extreme rapidity of operation gives place to inquiries into the best methods of executing the details of duty, and of throwing into the practical operations of the ship-builder some of the genuine principles of science. Let us hope that this great country, which owes its proud and commanding position among the nations of the earth so essentially to its marine, will lose no opportunity of imparting to it every improvement that the enlarged experience of modern times has disclosed; and to prepare it, if the unfortunate destiny of man should so require, for a more splendid and triumphant maintenance of the national honour and glory than even our former brilliant achievements displayed.

II.—*Algæ Britannicæ, or Description of the Marine and other Inarticulated Plants of the British Islands belonging to the Order Algæ; with Plates illustrative of the Genera.* By ROBERT KAYE GREVILLE, LL. D. &c. &c. 8vo. Edinburgh, 1830.

To the lovers of Botany the name of Dr Greville is well known. His *Scottish Cryptogamic Flora*, unrivalled for accurate and beautiful figures of plants hitherto but little studied in Scotland, and his *Flora Edinensis*, not to speak of his other contributions to phytology, have placed him in the first rank among British botanists. The present volume, with its elegant plates, is calculated still further to extend his reputation, and spread a wider taste for marine botany. Those numerous individuals who visit our sea shores for health or relaxation, will find this work of Dr Greville a valuable guide to the submerged vegetation which fringes the rocky shores of Britain; and, by pointing out wonders in beauty and structure where the unpractised eye sees nothing uncommon, lead many to observe and appreciate the thousand sources of enjoyment which nature has so liberally provided. Had he added the *Confervæ* of Linnæus (the Vaucherideæ, Ectocarpoideæ, and Confervoideæ of the *Flora Edinensis,*) to the volume, it would have been more generally useful, as numbers of these very beautiful plants are found in the same localities as the Inarticulated Algæ. These, however, may perhaps form the subject of a future work.

In the introduction Dr Greville gives a slight historical sketch of the writers who have gone before him in this branch of botany,—an outline of the geographical distribution of the Inarticulated *Algæ,*—and a few notices on the economical uses to which they are applied..

The arrangement of the *Algæ* followed in this volume is Dr Greville's own; having found reason, he says, from investigations of their structure and fructification, to differ from the previous classification of Lamouroux and Agardh. He divides the *Algæ* into fourteen orders, viz. Fucoideæ, Lichineæ, Laminarieæ, Sporochnoideæ, Chordarieæ, Dictyoteæ, Furcellarieæ, Spongiocarpeæ, Florideæ, Thaumasieæ, Gastrocarpeæ, Caulerpeæ, Ulvaceæ, and Siphoneæ. These orders are composed of eighty-nine genera. "A synopsis of these genera in the Latin tongue, with a systematic enumeration of all the better known species, with authoritative references,"

forms the first part of the volume. The more detailed portion of the work, devoted to British species, is wholly in English, and is particularly intended for the use of our fair and intelligent countrywomen, as a "guide to some of the wonders of the Great Deep." To the ladies, indeed, marine botany is indebted, as Dr Greville remarks, for much of what is known upon the subject; and Mrs Griffiths and Miss Hutchins have received the highest honour which one botanist can bestow on another, by having their names adopted as generic appellations.

Though "individuals do unquestionably exist," says Dr Greville, "who in the pride of their philosophy pronounce botany to be a frivolous pursuit—or a profitless science, whose chief feature is a lexicon of barbarous terms—or a pretty lady-like amusement;" yet it "is now becoming a favourite study and an elegant recreation, without meeting with more than an occasional sneer from the class above-mentioned, or a faint ejaculation from the matron of the old school, who remembers to have been told in her early days, that young ladies, at least, were more profitably employed in adding to the family receipt-book, and confining their natural history to indescribable performances in cross-stitch." Dr Greville might have added, as a conclusive answer to all such observations regarding the utility of the study of the minutest objects in nature, made generally by persons supremely ignorant of physical science, that what Infinite Wisdom and Beneficence has created and supports, cannot be accounted unworthy the notice of such a being as Man. And it is the opinion of a celebrated philosopher (Dugald Stewart,) that "the external objects with which we are surrounded, are so accommodated to our capacities of enjoyment, and the relations which exist between our frame and that of external nature are so numerous, in comparison of what we perceive in the case of all other animals, as to authorize us to conclude, that it was chiefly with a view to our happiness that the arrangements of this lower world were made." We take leave further to remark, that, in addition to the intellectual pleasure connected with the study of nature, so eloquently set forth by Dr Greville in his introductory pages, and which studies, besides, irresistibly lead to the contemplation of "the glory of that Almighty Being from whom so many wonders emanate," it would be no small attraction to our solitary sea-side walks, in search of *Algæ* and Corallines, to meet a fair countrywoman occasionally,

> ——— ———"Like Proserpina gathering flowers,
> Herself the fairest flower."

Independently, however, of the interest attached to the *Algæ* as objects of natural history—or as contributing to the income of coast proprietors in the shape of kelp or manure—many species are used as food, either from necessity or choice. "*Porphyra laciniata* and *vulgaris* is stewed, and brought to our tables as a luxury, under the name of *Laver*;"—and "on the southern and western coasts of Ireland our own *Chondrus crispus* is converted into size for the use of house-painters, &c.; and if I be not erroneously informed, is also considered as a culinary article, and enters into

the composition of *Blanc-mange*, as well as other dishes." From the proportion of iodine likewise contained in many species of *Algæ*, their use as articles of the Materia Medica is introduced, we believe, with effect, in cases where the prescription of that mineral is indicated.

A work of the nature of Dr Greville's, is not susceptible of analysis; we shall therefore quote from his introduction some remarks regarding the geographical distribution of the Marine *Algæ*. "To a considerable extent," he observes, "they seem to obey the same laws as the higher orders of vegetable forms. But it is doubtful if we are at present acquainted with all the agents which influence the growth of plants in a medium so different from air as that of water.——The distribution of the marine *Algæ* engaged the attention of the late Professor Lamouroux, whose essay upon the subject was published posthumously, in the 7th vol. of the *Annales des Sciences Naturelles*. M. Bory de St-Vincent has also added some observations, but mixed up with a good deal of extraneous matter, in the botanical part of Duperry's voyage round the world.

"It is very clear, and well known to the practical botanist, that marine plants are much influenced by the nature of the soil, not merely in regard to species, but in luxuriance and rapidity of developement. A few yards is in some instances sufficient to create a change, and the space of three or four miles a very striking one. Thus calcareous rocks favour the production of some species, sandstone and basalt that of others; and it would appear that the soil has an effect even upon those *Algæ* which grow parasitically upon the stems of the larger species. But sometimes, to all appearance independently of this cause, peculiar forms predominate in certain localities, both in regard to genera and species, which, as we approach their boundaries, gradually disappear, and often give place to others equally characteristic.

"Phænogamous plants have furnished botanists with several grand vegetable regions, and a marked difference (not to specify more examples) has been recognized between the plants of America, Africa, Asia, Australia, and Europe. Lamouroux endeavoured to trace these great divisions among marine plants, and observed that the polar Atlantic basin, to the 40th degree of N. latitude, presents a well-marked vegetation. The same may be said of the West Indian sea, including the gulf of Mexico—of the Eastern coast of South America—of the Indian ocean and its gulfs,—and of the shores of New Holland and the neighbouring islands. The Mediterranean possesses a vegetation peculiar to itself, extending as far as the Black Sea, and notwithstanding the geographical proximity of the port of Alexandria and the coasts of Syria to these of Suez and the Red Sea, the marine plants of the former, in regard to species, differ almost entirely from those of the latter. Bory de St-Vincent characterizes each of his Mediterranean seas by a vegetation different from that of the Arctic, Atlantic, Antarctic, Indian and Pacific oceans, and, to a certain extent, he is probably correct, as such seas are of less depth, often of a higher temperature, and more directly influenced by the countries which more or less inclose them. The seas which he considers as Mediterranean, are the Mediterranean, properly so called, the Baltic Sea, the Red Sea, the Persian Gulf, the Chinese Sea, the

Seas of Okhotsk and Bhering, and the West Indian Sea, along with the Gulf of Mexico, denominated by him The Columbian Mediterranean.

"Every great zone presents a peculiar system of existence; and it is said, that after a space of twenty-four degrees of latitude a nearly total change is observed in the species of organized beings, and that this change is mainly owing to the influence of temperature. Lamouroux remarks, that if this holds good, as we know it to do, to a wonderful extent in phænogamous plants, it should also exert some corresponding force upon marine vegetation. It is unquestionable that the *Algæ* are found on our own coast in the greatest abundance during the summer months, and in unusual luxuriance in hot seasons. It is probable also, observes the same author, that these plants may be acted on by the temperature of the water at greater or less depths; and that the species which grow at the bottom of the ocean may have some resemblance to those of the Polar circle. On the shores of the British Islands it is easy to perceive that some species, *Gelidium corneum*, *Phyllophora rubens*, and *Sphærococcus coronopifolius*, for example, become more plentiful and more luxuriant as we travel from north to south; and, on the other hand, that *Ptilota plumosa*, *Rhodomela lycopoidiodes*, *Rhodmenia sobolifera*, and several others occur more frequently, and in a finer state, as we approach the north. *Odonthalia dentata* and *Rhodomenia cristata* are confined to the northern parts of Great Britain, while the *Cystoseiræ*, *Fucus tuberculatus*, *Haliseris polypodioides*, *Rhodomenia jubata*, *R. Teedii*, *Microcladia glandulosa*, *Rhodomela pinastroides*, *Laurencia tenuissima*, *Iridea reniformis*, and many others, are confined to the southern parts. Others again, such as the *Fuci* in general, the *Laminarieæ*, many *Delesseriæ*, some *Nitophyllæ*, *Laurentiæ*, *Gastridia* and *Chondri*, possess too extended a range to be influenced by any change of temperature between the northern boundary of Scotland and the south-western point of England. The researches and calculations of Lamouroux have demonstrated satisfactorily, that the great groups of *Algæ* do affect particular temperatures or zones of latitude, though some genera may be termed cosmopolite. Setting aside the great division of articulated *Algæ*, of which we know but little, the *Siphoneæ*, or at least the genus *Codium*, and the Ulvaceæ, are scattered over every part of the world. *Codium tomentosum* is found in the Atlantic, from the shores of England and Scotland to the Cape of Good Hope; in the Pacific from Nootka Sound to the southern coast of New Holland. It abounds in the Mediterranean, on the shores of France, Spain, and Africa, and is common in the Adriatic. More recently it has been also brought from the coasts of Chili and Peru. This plant, however, is not a social one—to make use of a term that Humboldt has applied to some phænogamous plants. It grows even in the same locality, in a solitary and scattered manner. The *Ulvaceæ*, on the contrary, are strictly social, and preserve this character in every part of the world. They appear, however, to attain the greatest perfection in the polar and temperate zones, although I have very fine *Porphyræ* from the Cape of Good Hope. That they are capable of sustaining very extreme cold, is proved by the fact, that fine specimens of *Enteromorpha compressa* were picked up in high latitudes of the Arctic Ocean, by some of the gentlemen who accom-

panied Capt. Sir Edward Parry in his second voyage of discovery. The *Dictyoteæ*, of which we have eight representatives in Scotland, and thirteen in England, increase both in quantity and number of species as we approach the Equator. The *Fucoideæ*, in a general sense, increase as we leave the polar zone, especially in the variety of species. But the natural groups into which they are separated, are strongly marked in their distribution. The *Fuci* flourish between the latitudes 55° and 44°, and, according to Lamouroux, are rarely seen nearer to the equator than 36°. *Fucus serratus* is entirely confined to Europe. If the imperfectly known *Macrocystis comosa* and *Menziesii* should prove to be true *Fuci*, the latter will be an exception to the rule, as it is said to be found at Trinidad, as well as on the western coast of North America. The large genus *Cystoseira* is found between the 50th and 25th degrees of latitude, becoming more plentiful as the *Fuci* diminish. In New Holland, remarkable alike for its vegetable and animal productions, a distinct group of *Cystoseiræ* predominates, as singluar in the water as the aphyllous *Acaciæ* are on the land. Their stems are compressed, often appearing to be jointed; the branches spring from the flat side, and not from the angles, and are deflexed at their insertion; besides which, their vesicles are solitary and pedicellate. This most extraordinary and local group, including some new species kindly communicated to me by Mr Fraser, the colonial botanist at Sydney, is already known to consist of twenty species. The genus *Sargassum*, the most extensive of the *Fucoideæ*, comprising above seventy species, is nearly confined to the two tropics, and examples rarely occur beyond the 42d degree in either hemisphere. The Red Sea is full of *Sargassa*. It is principally to one or two species of *Sargassum* that the popular name of gulf-weed has been applied by mariners. The prodigious accumulation of these plants were first encountered by the early Portugese navigators; Columbus and Lerius compare them to extensive inundated meadows, and state that they absolutely retarded the progress of the vessels, and threw the sailors into consternation. Such accumulations occur on each side of the Equator, in the Atlantic, Pacific, and Indian oceans."—" In the genus *Sargassum* is observed a small group, as local and almost as peculiar as that we have shown to exist in *Cystoseira*. This occurs in the seas of China and Japan, and consists of *Sargassum fulvellum, microceratium, macrocarpum, sisymbrioides, Horneri, pallidum,* and *hemiphyllum,* distinguished from the rest by terminal fructification, a slender habit, small nerveless leaves, and often elongated vesicles.

" The *Laminarieæ*, among which are the giants of the marine flora, exhibit, in a broad view, a tolerably decided geographical distribution. The *Laminariæ* predominate from the 40th to the 65th degree of latitude; while the *Macrocystes* seem, as far as we know, to exist from the equator to about 45° of south latitude.

" The only order of any extent remaining to be noticed is *Floridæ*. This order, generally speaking, belongs, according to Lamouroux, to the temperate zones; and in this conclusion I think he is correct. But, as might be anticipated, in an order which contains so large a number of genera and species, there are many exceptions. The genus *Amansia* is

exclusively tropical. *Hypnæa* and *Acanthophora* belong also rather to the tropical than the neighbouring zones. It is worthy of notice, that comparatively speaking, the southern temperate zone contains much fewer *Florideæ* than the northern; a fact that Lamouroux thinks may be accounted for by the inferior extent of the temperate zone in that hemisphere.

"From the number of species known to Lamouroux, he calculated that the *Florideæ* predominate greatly over the *Fucoideæ*; the latter over the *Ulvaceæ*, and these last again over the *Dictyoteæ*. He estimated the number of species known to botanists (including the articulated *Algæ*,) to be 1600, which is certainly considerably exaggerated. The total amount of species supposed to exist was conjectured by the same author to be at least five or six thousand. If this be an approximation to the truth, we cannot be said to be well acquainted with a fifth part of the subaqueous vegetation of the globe."

We conclude with strongly recommending Dr Greville's work to the attention of British botanists. The accuracy of his descriptions, and the beautiful plates by which the generic characters are exemplified, leave nothing to be wished for in these respects. Our only regret is, that the price of the book, perhaps necessary to cover the unavoidable expence of the coloured figures, had not been somewhat lower; for it is one of the evils of high priced books, that they are thus placed within the reach of few, and these not always the best qualified to appreciate their value; while thousands, to whom fortune has not been equally kind, are by this means deprived of the opportunity of cultivating intellectual pursuits, and thus practically interdicted from many of the noblest enjoyments of rational beings. To this cause chiefly may be attributed the slow progress of the natural sciences in this division of the kingdom.

Art. XXV.—PROCEEDINGS OF SOCIETIES.

1. *Proceedings of the Royal Society of Edinburgh.*

December 7, 1829.—The following Gentlemen were duly elected ordinary Members of the Society:—

James Walker, Esq. W. S.

William Bald, Esq. M. R. I. A.

Whitelaw Ainslie, M. D., &c.

December 21. The following communications were read:

1. Remarks on the Osteology and Dentition of the Dungong. By Dr Knox.

2. A notice regarding some observed Anomalies in the Phenomena of the Atmosphere. By Sir George S. Mackenzie, Bart.

The following objects of Natural History, formerly presented to the society by Mr Swinton, and prepared by Dr Knox, were exhibited:

Cranium of the Dungong and cast of do.

Skeleton of the long-armed Gibbon, Boa, and Iguana.

Two lizards and an alligator from the Irawaddy.

Twenty-seven specimens of ophidian reptiles.

January 4, 1830.—The following communication was read :—

Observations on the Structure of the Stomach in the Peruvian Lama. By Dr KNOX.

January 18.—Sir GEORGE MACKENZIE, Bart. read the first part of a paper entitled, An Elucidation of the Fundamental principles of Phrenology.

February 1.—COLONEL PITMAN of the Hon. E. I. Company's Service was duly elected an Ordinary Member.

Sir GEORGE S. MACKENZIE, Bart. concluded his paper on the Fundamental Principles of Phrenology ; and the following communications were read :—

1. Remarks explanatory, and Tabular Results of a Meteorological Journal kept at Carlisle by the late Mr W. PITT, during twenty-four years. Part I. By THOMAS BARNES, M. D.

2. Chemical examination of Wad. By Dr EDWARD TURNER. See this Number, p. 213.

February 15.—Dr KNOX read a paper entitled, Observations illustrating the Laws which regulate hermaphroditical appearances in the Mammalia, and the extent to which their presence affects the functions of the more perfect animals. Part I. Observations to determine the male and female and equivocal organs of generation. See this Number, p. 322.

The Secretary read a letter addressed to the Society by the CHEVALIER ALDINI, in reference to his fire-proof clothing.

March 1.—The following Gentlemen were elected ordinary Members :

J. T. GIBSON-CRAIG, Esq.

ARCHIBALD ALISON, Esq.

Dr KNOX read the continuation of his paper begun at a former meeting Part II. On the Law of Hermaphrodism, and on the type of the Generative Organs in Animals.

2. *Proceedings of the Society for the Encouragement of the Useful Arts in Scotland.*

The following communications were read :

November 25, 1. An account of a French Authographic Printing Press, invented by PIERRON, Rue St Honorè, Paris, was read, and a specimen printed by it exhibited. Communicated by John Robison, Esq., Sec. R. S. E.

2. Observations on the proper construction of Pendulum Time-keepers, and proposed improvements in the construction of Pendulums, with relative sketch, were read and exhibited. By WILLIAM LAW, Linlithgow.

3. An account of the cause of Dry Rot in timber, and of a mode of preventing it, with specimens illustrative thereof, was read and exhibited. By JAMES BEATTIE, A. M. Rector of the Grammar School, Moffat.

December 9.—1. An account of the discovery of the Place, Revolutions, and regular Variations of the Principal Powers of Attraction connected with the F[illegible]d influencing the magnetic needle, with a lithographic

diagram, were read and exhibited. By THOMAS JOHNSTONE, Ferenze, Barrhead, Renfrewshire.

2. A Description and drawing of a simple, cheap, and accurate Rain-Gauge, calculated to show the depth of rain fallen to the ten-thousandth part of an inch, were read and exhibited. By MATHEW ADAM, A. M. Rector of the Royal Academy of Inverness, and Associate S. A.

3. An Account of a Phenomenon in Natural History, in the parish of Melrose, illustrated by a variety of specimens, were read and exhibited. By ALEXANDER SANDERSON, woollen cloth manufacturer, Galashiels.

December 23.—1. Specimens of Shawl Cloth manufactured at Edinburgh with thibet wool, and dyed with an extract from the flower of potatoes grown in Scotland, as suggested by the Right Honourable Sir John Sinclair, Bart. were exhibited. The process invented and executed by Messrs G. Page and Co. dyers, Prince's Street. Edinburgh.—Communicated by the Right Honourable Sir JOHN SINCLAIR, Bart.

2. A Description and Model of a new mode of Propelling and Directing the Motions of Steam Boats, were read and exhibited. By WILLIAM M'CRIRICK, gun-maker, Irvine.

3. A Description, Drawing, and Model of a Rheontometer or Rheumatometer, answering the purposes of an Anemometer and Ship's Log, were read and exhibited. By the Reverend JAMES BRODIE, Monimail.

4. Two Anemometers or Anemoscopes, invented some years ago by Andrew Waddell, Esq. of Hermitage Hill, Leith, and now presented by him to the Society of Arts, with a relative description, were read and exhibited.

Mr Charles Atherton, civil engineer, Edinburgh, was admitted an Ordinary Member.

The following communications have been read and exhibited to the Society since 1st January 1830:—

January 6, 1830.—1. A description, drawings, and engravings of a new Steam Engine without a Boiler. By ALEX. SCOTT, Esq. Ormiston. See last Number of this Journal, p. 21.

2. A description and sketch of a new mode of applying the water or moving power to Barker's mill. By CHARLES GREY, Esq.

3. A description and model of a machine for roasting coffee, malt, &c. &c. By WILLIAM LAW, coffee-merchant, Hanover Street, Edinburgh.

January 20.—1. A description of an improved Penatgraph, for copying, enlarging, or reducing plans, pictures, &c. By JOHN DUNN, optician, Edinburgh, M. S. A.

2. Observations on the doctrine of impulse. By the Rev. JAMES BRODIE, Monimail, Fife, Associate S. A.

3. A model and description of a Locking Bar, for affording strength and security, principally for shop-doors. By Messrs JOHN and WILLIAM GREIG, smiths, Rose Street, Edinburgh.

4. A description of a Geometrical Square for cutting coats, with a lithographic drawing. By ADAM GEDDES, tailor, Frederick Street, Edinburgh. The instrument was exhibited.

William Bonar, Esq. F. R. S. E. was admitted an Ordinary Member.

February 3.—1. A model and description of an improved Carriage Drag. By ROBERT RUSSELL, mill-wright, Denny, Loanhead.

2. A description and drawing of a new Cross-cutting Saw. By DIXON VALLANCE, Libberton, Lanarkshire.

3. A description and drawing of an improved Indicator for steam engines, and of an Oil Test. By JOHN M'NAUGHT, engineer, Robertson Street, Broomielaw, Glasgow.

4. A model, drawings, and description of a Horizontal Air Pump. By JOHN M'CLEISH, Esq. Maryfield, Edinburgh, M. S. A.

Mr Robert Kirkwood, engraver, was admitted an Ordinary Member.

February 17.—1. A model, drawing, and description of a new Iron Bridge. By ADAM WILSON, smith, Mint, Edinburgh.

2. A model and description of Safety Windows for upper stories of houses. By THOMAS JOHNSTON, ink manufacturer, Glasgow.

3. A description and engraving, and directions for using an Extinguisher for females' dress on fire. By THOMAS JOHNSTON, ink manufacturer, Glasgow.

Henry Tod, Esq. W. S. was admitted an Ordinary Member.

3. *Proceedings of the Cambridge Philosophical Society.*

February 22, 1830.—The Rev. Professor Farish, one of the Vice-Presidents, being in the chair,

A paper was read by J. Challis, Esq. of Trinity College, on the integration which on certain suppositions can be effected of the general equations of the motion of fluids; and on the application of the results to the solution of various problems. Among other cases Mr Challis considered that of a stream of air issuing through an orifice in a plane, and flowing against a plate placed near to the orifice. It appears that the theory gives in this instance a pressure urging the plate towards the plane, such as is found to exist by experiment.

A paper was also read by the Rev. L. Jenyns, on the Natter-Jack (*Bufo rubeta*) of Pennant, containing an account of its habits, collected from the observations of several individuals of the species during a period of two months; and to these notices was added an enumeration of the Reptiles found in Cambridgeshire.

After the meeting, Professor Henslow gave an account of the discoveries recently made with respect to *endosmose* and *exosmose*; and of the application of these principles to the explanation of the motion of the sap in plants; with some considerations on the theory for the explanation of these phenomena proposed by M. Poisson.

March 8.—A communication from the Rev. C. P. N. Wilton of St John's College, was read, containing an account of a visit to Mount Wingen, a burning mountain in Australia. See this No. p. 270.

Mr Coddington explained the principle of a microscope of a new and simple construction, which had been made according to his directions by Mr Cary, and which he exhibited to the Society.

After th Professor Airy gave an account, illustrated by models, of the inst ave been used at different periods, and in different count se of measuring the altitudes of stars. He de-

scribed particularly the zenith sector, the quadrant, the repeating circle, the great declination circles of Troughton, and the circle of Reichenbach's construction; and instituted a comparison between the two last as the declination instruments which at present are principally used in European observatories.

Art. XXVI.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

OPTICS

1. *On the Manufacture of Glass for optical purposes.* By Mr Faraday, Esq. F. R. S.—The following is an abstract of Mr Faraday's paper on this important subject. The author, being intrusted with the superintendence of the experimental part of the manufacture of the glass, conceives it to be his especial duty, at the present stage of the inquiry, to give an account of what has been done in his department; for although the investigation is yet far from being completed, he trusts that a decided step has now been made in the manufacture of glass for optical purposes, and that it is due to the Society, as well as to the government, to render an account of the results hitherto obtained. The author begins this account by a statement of the usual defects incident to glass, which destroy the regularity of its action on light. These are, on the one hand, streaks, striæ, veins, and tails; and, on the other hand, minute bubbles; the former arising from the want of homogeneity—the latter from the intermixture of air. Of these, the first class of defects constitute the most serious evil, as they interfere with the rectilineal course of the rays of light while traversing the glass; while the latter are injurious merely from the interception of the rays, and their dispersion in all directions. The greater the difference in specific gravity of the ingredients of the glass, the greater is the tendency to form striæ when they are fused together: hence flint glass, which contains a large proportion of lead, is more liable to this defect than either crown or plate glass. After numerous trials of materials different from those which enter into the composition of the ordinary kinds of glass, borate of lead and silica were fixed upon as the most eligible; and as near an approximation as possible to a definite chemical union of their elements was arrived at, by taking single proportionals of each, and endeavouring to procure them, previous to combination, in the greatest possible state of purity. The oxide of lead was obtained from the nitrate of the metal previously crystallized. The boracic acid was also selected from the purest crystals afforded by the manufacturer, and carefully tested to ascertain its freedom from foreign matters. The silica employed was that of flint-glass-makers' sand, well washed and calcined, and freed from iron by nitric acid. It was afterwards combined with protoxide of lead. These materials were then mixed, in the proportion of 154.14 parts of nitrate of lead, 24 of silicate of lead, and 42 of crystallized boracic acid, and melted together in a separate furnace, adapted expressly for this preliminary operation, and of which a minute description is given. A tray was then prepared of thin laminæ of platina—all the apertures of which were carefully closed by soldering—

for containing the pulverized glass, which was to be subjected to the final melting in a furnace of peculiar construction, which the author terms the finishing furnace. After numerous trials of substances for constructing the chamber in which the fusion of the glass contained in the tray was to be conducted, recourse was had to the materials from which the Cornish crucibles are manufactured, and which were obtained through the kindness of the president, and were expressly manufactured for the purpose by Mr Mitchell of Cornwall. In order to prevent the reduction of any portion of the lead entering into the composition of the glass, a current of fresh air was introduced by a tube, and made to pass along the surface of the fused glass. A very minute and circumstantial account is given of all the manipulations necessary for conducting these processes in all their stages; in some of which, however, the best methods of proceeding yet remained to be ascertained—variations having been made up to the very last experiment; and it is only by still more extensive experience that the author expects the proper arrangements will ultimately be settled. Directions are given as to the occasional inspection of the glass during the process, the mode of stirring by a rake of platina, and the plan devised by the author of accelerating the disengagement and escape of bubbles, by throwing into the melted materials a quantity of pulverized platina mixed with fragments of the same kind of glass. The glass which has been obtained by the mixture of the materials above-mentioned, constituting silicated borate of lead, has a specific gravity of 5.44, and high refractive and dispersive powers, and, perhaps, also very considerable reflecting power.* It is softer than ordinary glass, but less liable to be tarnished by sulphureous vapours, as they usually exist in the atmosphere; and also less acted upon by moisture than glass into which potash enters as an ingredient; it is likewise a much more perfect electric than common glass.—*Lit. Gazette.*

2. *Effect of light on Liquids.* By M. Dutrochet.—On the 18th January 1830, M. Dutrochet addressed a letter to the Institute, the object of which was to establish that light is an occasional cause of motion in liquids, and *that water in the state of liquidity possesses two very different molecular states, which appear to be analogous, the one to a regular aggregation, and the other to a confused aggregation of solid molecules.*

On the 25th January, the Institute received from M. Dutrochet a second communication relative to the influence of light on the motion of liquids. He had established that a difference of temperature was the efficient cause of the circulating motion in liquids, $\frac{1}{600}$ of a degree of difference being sufficient with the aid of light. New experiments have proved that in the absence of this agent the circulating motion stops. When the windows are shut, so as to leave only enough of light to distinguish the circulating motion when it exists, this motion is immediately suspended. When the windows are again opened the motion recommences. When it is again completely suspended by the absence of light, if we tap upon the table on which the [illegible]s, this slight movement instantly re-establishes the cir-

* The l[illegible]he better; but this depends entirely on the refractive power.—E

culating motion. A slight sound, such as that of a bell, was sufficient to restore the circulating motion.

From these new experiments it follows, that the agitation of the molecules of a liquid favours their circulating motion under the influence of a slight inequality of temperature; that this previous agitation is an indispensable circumstance, and consequently that light produces this circulating motion only by agitating the molecules of liquids. Hence M. Dutrochet concludes, that in the phenomenon of the circulation of liquids two causes intervene, one *efficient*, viz. the difference of temperature, the other *occasional*, viz. *light* or whatever is susceptible of agitating the molecules of liquids.

METEOROLOGY.

3. *Meteor at Plymouth.*—On the 30th August, between 10 and 12 o'clock, P. M. a meteor appeared at Plymouth between the stars Alioth and Megrez of Ursa Major, which instantaneously lighted up the whole hemisphere with uncommon splendour for a second of time, and left a short train of about two degrees in length between the two stars. The light was exceedingly lucid and clear.—*From a Correspondent.*

II. CHEMISTRY.

4. *Reduction of Nitrate of Silver.*—In 1826, M. Charles de Filiere had occasion to have prepared by one of his pupils a considerable quantity of nitrate of silver. He placed the finest crystals in unsized paper, which was carelessly thrown into a card box, and consequently prevented from coming into contact with bodies suspended in the atmosphere.

Having found in the beginning of the month of November (1829, we suppose,) this packet, the paper envelope of which had received as usual a deep violet tint, he was surprised to find that his fine crystals, without having lost their form, *had become plates of metallic and very malleable silver.*—*Ann. de Chim.*

5. *Notice on the Atacama Meteoric Iron.* By Dr Turner.—In the former series of this *Journal*, vol. ix. p. 262, an analysis of the meteoric iron from Atacama is inserted from the *Transactions of the Royal Society of Edinburgh.* I was not aware at the time, that the result of a careful analysis, sent to the printer for insertion, had been omitted. The composition of the mass in 100 parts is as follows:—

Iron,	93.57
Nickel,	6.618
Cobalt,	0.535
	100.723

6. *Mineral water of Ronnely.*—Ronnely lies in the province of Bleking, in Sweden, 15 or 20 miles from Carlscrona, and is much frequented for its mineral water. This water has a spec. gravity of 1002.55, and, according to the analysis of Berzelius, contains in 1000 parts

Protosulphate of iron, -	1.0686
——————— manganese, -	0.0260
Sulphate of zinc, - -	0.0133
——————— lime, - -	0.3705
——————— magnesia, - -	0.1716
Ammonia alum, - -	0.2126
Soda alum, - - -	0.4790
Potash alum, - -	0.0433
Chloride of aluminum, - -	0.0230
Silica, - - -	0.1151
	2.5230

One of the very few known mineral waters of a similar kind is that at Sandrock, in the Isle of Wight, which is, however, three times as strong as the water of Ronnely, having a spec. gravity of 1007.5 and containing, according to Marcet, in an English pint

Crystallized sulphate of iron, - - -	41.4 grains.
Sulphate of alumina, which can be obtained in the state of crystallized alum, - - - -	31.6
Crystallized gypsum, (sulphate of lime,) - -	10 1
Crystallized sulphate of magnesia, - - -	3.6
——————— soda, - - -	16.0
Common salt, - - - - -	4.0
Silica, - - - - - -	.7
	107.4 grains.

It is obvious, that in the use of such mineral waters as these, great care must be exercised; for with such ingredients they may speedily produce serious effects upon those who use them indiscreetly.

7. *Atomic weight of Iodine and Bromine.*—Berzelius has lately published in the *Transactions of the Swedish Academy*, some very careful analyses of the Iodide and Bromide of silver, from which he deduces the following results:—

Atom of iodine = 789.749
Double atom = 1579.498
Spec. grav. of gaseous iodine = 8.7078
Iodic acid consists of { 75.942 iodine / 24.058 oxygen
Hydriodic acid of { 99.216 iodine / 0.784 hydrogen

And its specific gravity by calculation = 4.8883, being only 0.0517 different from Guy-Lussac's experimental result:—

Atom of bromine = 489.15,
Double atom = 978.3,
Spec. grav. of gaseous bromine = 5.3934
Bromic acid = { 66.177 bromine, / 33.823 oxygen,

Hydrobromic acid = { 98.73 bromine, 1.27 hydrogen,

And the spec. grav. of gaseous hydrobromic acid = 2.7311.

It will be remembered that Dr Thomson's number for iodine is 15.5. and that Balard's two experiments gave for that of bromine 932.6, and 942.9; while Liebeg's later experiments gave for that of bromine 942.9.

8. *Analysis of a Meteoric Stone.*—This stone fell in Macedonia, and was analyzed by Berzelius at the request of Mr Schener of Vienna, for a work on meteoric stones which he is preparing.

It was of a grey colour, intermixed with round transparent specks; and with points of a dark or brown colour and metallic lustre, showing it to be an aggregate of several different substances. Rubbed to powder, the magnet separated it into two portions; and the non-magnetic portion treated with acids left 52½ per cent. of insoluble matter.

The *magnetic* portion consisted of

Iron, - - -	88.36
Nickel, with a trace of cobalt, -	4.80
Sulphur, - - -	6.83
	100

and was a mixture of nickel, iron, and magnetic pyrites, both of which the magnet had drawn out together.

The *non-magnetic* portion soluble in muriatic acid consisted of

Silica, - - -	28.70
Protoxide of iron, - -	29.60
Magnesia, - - -	40. 0
Potash, - - -	8
Soda, - - -	9

having the composition of olivine, with this difference, that the oxygen in the bases is to that in the silica, as 3 : 2.

The insoluble portion consisted of a mixture of the silicates of potash and soda, iron, manganese, lime, alumina, magnesia, with one per cent. of protoxide of chromium, and .2 per cent. of oxide of nickel.—*Transactions of the Royal Academy of Sciences of Stockholm.*

III. NATURAL HISTORY.

MINERALOGY.

9. *Analysis of Allophane from Firmi in the Aveyron.* By M. J. Guillemin.—The specific gravity was 1.76 at 19° Reaum.

	Firmi Guillemin.	Schneiberg Stromeyer.
Silex, - - -	22.00	21.92
Alumina, - -	35.00	32.20
Water, - -	42.00	41.30
Sulphuric acid, - -	0.75	0.52
Lime, - - -	traces,	0.73
Oxide of iron, - -	0.00	3.33
Carbonate of copper, -		
	99.75	100.00

As these numbers agreed ill with the theory of definite proportions, he repeated the analysis with care, and obtained the following results:—

		Oxygen.
Silex, - -	23.76 containing 11.95	6
Alumina, - -	39.68 18.58	9
Water, - -	35.74 31.78	16?
Sulphuric acid, -	0 .65 0.38	
Lime, - -	traces.	

It consists, therefore, of two atoms of bi-hydrate of alumina, one atom of bi-silicate of alumina, and four atoms of water, neglecting the sulphuric acid. It ranks next *Halloysite.—Ann. de Chim.*

10. *Mineral Pitch near St Agnes, Cornwall, discovered by* Mr Henwood.—This substance has been discovered by Mr Henwood in the copper veins of south Huel Towan Mine, near St Agnes, Cornwall. It accompanies iron and copper pyrites, and coating crystalline quartz. It occurs abundantly in the small cavities which exist in the veins. Excepting in the Carharrack Mine, we believe it has never before been observed in that county.

11. *Fresh discovery of the Chromate of Iron in Shetland.*—The abundance in which this ore is found as a constituent of the serpentine rock, is now adding considerably to the wealth of this remote province of Scotland. The landed proprietors continue in an active search after it, as the following extract of a letter, dated the 27th of January 1830, sufficiently shows. It is addressed to Dr Hibbert from Thomas Gifford, Esq. of Busta, a principal landed proprietor in these islands: "I take the liberty," he writes, "of addressing a few lines to you on the subject of the chromate of iron. As you predicted, it has been found in quantity on the Ness of Hillswick and elsewhere in Northmavine."

ZOOLOGY.

12. *Observations on Serpents.* By M. Desvoidy.—On the 19th October 1829, M. Robineau Desvoidy communicated to the Institute the two following observations. 1. In a clayey and sandy soil he found a great quantity of the *Anguis fragilis* of Linnæus, the *common Blind Worm*, and in opening one of the largest, he found six young ones alive, and more or less developed. 2. Having dissected a viper, one of these commonly called in France the *Red Serpent*, he found in the uterus more than 3000 young ones in different states.

13. *Account of another case of United Twins in the East.*—The union of twins by a corporeal band, as in the example of the two Siamese youths now exhibiting in the metropolis, is a phenomenon not unparalleled, especially in the East, where *lusus naturæ* are, perhaps, more frequent than in other parts of the world.

We are favoured with a well-authenticated instance of a similar, but more remarkable, union of twins, in India, which is communicated to us by a gentleman who, in 1807, when on deputation in the province of Coimbatore, as a member of the Board of Revenue at Madras, personally examined the two children, and by whom the following description was drawn up, from observation, at Bhavany. The particulars are not so exact and technical as if they had been the result of medical inspection, which is much to be regretted; but no professional person was then at the station. A sketch of the appearance presented by the children accompanies the description, but it is too imperfect to afford any additional elucidation.

The children were females, and born at a village in Coimbatore, in the month of October 1804. At the period of examination, October 1807, they were, of course, three years old. One of them was thirty-four inches high, the other a quarter of an inch shorter. The heads of both were rather long, and the sides of each head much compressed; the features of each strongly resembled the other. The bodies were joined from the lower part of the breast-bone to the navel, which was common to both. They were thus face to face, and could sleep in no other position. In walking, they moved sideways, and sometimes circularly. They generally slept at the same time, but not always; and one would cry whilst the other did not. If the body of one was pinched, the other did not appear to feel; but if the connecting part was pinched, both were sensible of pain. Medicine administered to one affected both. The evacuations of each were regular, but at different periods. Both were healthy children, and not otherwise deformed. One was loquacious; the other talked very little; the liveliest was rather stouter than the other. Both had had the small-pox, at the same time, and favourably. In moving or looking different ways, or rather in directions contrary to their natural position, they crossed their hands and arms. They could walk up stairs, and were active when playing with other children.

The mother of these girls was a woman of the weaver caste; she did not, according to the statement of the father, who attended them, suffer particularly in bringing them into the world. The same woman subsequently was delivered of separate twins, which were living at the time when this examination took place.

What became of this curiously united pair we are not told. it is probable, and perhaps to be hoped, considering how severe a tax existence must be in such circumstances, that their lives were not prolonged.—*Asiatic Journal*, No. 1, New Series, p. 17.

Art. XXVII.—LIST OF PATENTS GRANTED IN SCOTLAND SINCE JULY 15, 1829.

15. July 8. For an Improved method of constructing Ships' Pintles for hanging the Rudder. To John Lichou, county of Middlesex.

16. August 4. For a Machine or Engine for dressing of Stones used in Masonry by the assistance of a Steam Engine, a Wind, a Horse, or a Water Power. To James Milne, Edinburgh.

17. August 14. For certain Improvements in the application of Elastic dense Fluids to the Propelling or giving Motion to Machinery of various Descriptions. To RICHARD WILLIAMS, county of Middlesex.

18. August 28. For an Improvement in the construction and setting of ovens or retorts for carbonizing coals for the use of Gas Works. To BARNARD HENRY BROOK, county of York.

19. August 28. For certain Improved machinery for Preparing or Kneading Dough. To MOSES POOLE, Lincoln's Inn.

20. August 28. For a certain Improvement in the article commonly called Stick Sealing Wax. To PETER RIGBY MASON, Middle Temple.

21. September 2. For certain Improvements in Power Looms for Weaving Cloth. To WILLIAM RAMSBOTTOM, Manchester.

22. September 2. For certain Improvements on machines or machinery for Scraping, Sweeping, Cleaning, and Watering Street Roads and other Ways. To JOHN BOASE and THOMAS SMITH, London.

23. September 7. For certain Improvements on machinery for Making Lace, commonly called Bobbin Net. To JOHN LEVERS, Nottingham.

24. September 16. For certain Improvements in Machinery for Propelling Vessels and giving Motion to Mills and other Machinery. To WILLIAM POOL, city of Lincoln.

25. September 23. For certain Improvements in Steam-Engines and in Machinery for Propelling Vessels, which Improvements are applicable to other Purposes. To ELIJAH GALLOWAY, Burgh of Southwark.

ART. XXVIII.—CELESTIAL PHENOMENA,

From April 1st, to July 1st, 1830. *Adapted to the Meridian of Greenwich, Apparent Time, excepting the Eclipses of Jupiter's Satellites, which are given in Mean Time.*

N. B.—The day begins at noon, and the conjunctions of the Moon and Stars are given in Right Ascension.

APRIL.

D.	H.	M.	S.	
*5	8	31	47	☽ ☌ ♈ ☽ 34′ N.
6	7	45		♃ □ ☉
6	12	8	19	☽ ☌ ♑ ☽ 11′ S.
*7	14	44	44	☽ ☌ ♑ ☽ 37′ N.
7	19	29		○ Full Moon.
9	15	51	52	Im. II. Sat. ♃
12	16	7	21	Im. I. Sat. ♃
13				♄ Stationary.
14	17			☿ ☌ ♀ ♉
15	18	47		☾ Last Quarter.
18	22			☿ ☌ ☊
20	3	1		☉ enters ♉
21	19			☿ Sup. ☌ ☉
22	11	27		● New Moon.
24	13	18	1	☽ ☌ ♈ ♉ ☽ 47′ N.
24	14	29	46	☽ ☌ ♀ ♉ ☽ 61′ S.
24	14	57	30	☽ ☌ ♃ ♉ ☽ 53′ S.
26	17			♂ ☌ ♓
28	13			♂ ☌ ♑
28	14	22	48	Im. I. Sat. ♃
29	7	54		☽ First Quarter.
29	15			☿ ☌ ♃ ♈
30	18	45		♅ □ ☉

MAY.

2	2	30		♄ □ ☉
2	14	36	9	☽ ☌ ♋ ☽ 6′ S.
5				♃ Stationary.
6	4			☿ ☌ ♀ A ♉
7	12	2		○ Full Moon.
7	13	42	53	Im. III. Sat. ♃
8	2			♂ □ ☉
11	16			♂ ☌ ☽ ♌
13	11	18	15	☽ ☌ ♇ ♑
14	11			♂ ☌ ♃ ♑
15	0			♅ Stationary near ♑
15	4	18		☾ Last Quarter.
16	0			☿ Greatest Elong.
*16	16	37	32	☽ ☌ ♍ ☽ 76′ N.
21	0			☿ Greatest Elong.
21	14	32	32	Im. I. Sat. ♃

D.	H.	M.	S.	
21	19	13		● New Moon.
*22	6	17	23	☽ ☌ α ♉ ☽ 31′ N.
24	8			☿ ☌ 132 ♉
*27	10	55	8	☽ ☌ ξ ♌ ☽ 56′ N.
28	22	48		☽ First Quarter.
30	9	11	59	☽ ☌ β ♍ ☽ 7′ N.
31	12	28	53	☽ ☌ 1 χ ♍ ☽ 56′ S.
31	21			♀ ☌ ⚬ ♓

JUNE.

* 2	12	34	23	☽ ☌ κ ♍ ☽ 46′ N.
3				☿ Stationary.
5	12	22	46	Im. II. Sat. ♃
6	2	19		○ Full Moon.
6	12	49	4	Im. I. Sat. ♃
* 8	12	28	42	☽ ☌ α ♐ ☽ 59′ N.
12	12	38	33	☽ ☌ λ ♒ ☽ 50′ N.
13	10	49		☾ Last Quarter.
15	6	30		☿ Inf. ☌ ☉
17	11	46	24	} Im. IV. Sat. ♃
17	14	15	58	} Em. IV. Sat. ♃
18	10	38	2	☽ ☌ 1 ♐ ♉ ☽ 51′ S.
18	11	6	4	☽ ☌ 2 ♐ ♉ ☽ 29′ N.
19	13	35	56	Im. III. Sat. ♃
19	15			☽ ☌ ☿
20	33			● New Moon.
21	11	50		☉ enters ♋
22	11	6	15	Im. I. Sat. ♃
27				☿ Stationary.
27	15	16		☽ First Quarter.
*28	10	40	34	☽ ☌ θ ♍ ☽ 65′ N.
29	13	0	47	Im. I. Sat. ♃

Times of the Planets passing the Meridian.

APRIL.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	h	′	h.	′	h	′	h	′	h	′	h	′
1	22	55	21	51	18	59	18	25	8	14	20	5
7	23	12	21	37	18	54	18	6	7	53	19	45
13	23	31	21	27	18	48	17	46	7	30	19	23
19	23	53	21	20	18	53	17	25	7	8	19	1
25	0	14	21	15	18	36	17	4	6	46	18	40

MAY.

1	0	41	21	11	18	30	16	42	6	24	18	16
7	1	6	21	8	18	22	16	19	6	2	17	53
13	1	24	21	5	18	14	15	55	5	40	17	30
19	1	34	21	4	18	6	15	30	5	17	17	7
25	1	34	21	2	17	56	15	5	4	55	16	44

JUNE.

1	1	18	21	2	17	44	14	34	4	29	16	14
7	0	51	21	1	17	23	14	8	4	6	15	49
13	0	15	21	1	17	22	13	40	3	44	15	24
19	23	31	21	2	17	10	13	12	3	21	14	58
25	22	59	21	4	16	57	12	44	2	59	14	34

Declination of the Planets

APRIL.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	°	′	°	′	′		°	′	°	′	°	
1	5	23 S.	3	31 S.	22	18 S.	22	25 S.	18	26 N.	18	26 S.
7	1	5 S.	4	4	21	42	22	21	18	28	18	22
13	3	49 N.	4	8	21	1	22	19	18	28	18	20
19	9	7	3	43	20	15	22	17	18	27	18	18
25	14	27	2	59	19	25	22	15	18	25	18	17

MAY.

1	19	11 N.	1	44 S.	18	35 S.	22	15 S.	18	22 N.	18	16 S.
7	22	41	0	17 S.	17	33	22	16	18	18	18	15
13	24	41	1	24 N.	16	31	22	17	18	13	18	15
19	25	22	3	16	15	29	22	19	18	17	18	15
25	25	0	5	15	14	24	22	23	18	0	18	16

JUNE.

D.	h ′	h ′	h ′	h	h ′	h ′
1	23 38N.	7 40N.	13 7S.	22 27S.	17 51N.	18 17S.
7	22 0	9 46	12 2	22 32	17 42	18 20
13	20 17	11 51	10 58	22 37	17 33	18 22
19	18 58	13 51	9 55	22 42	17 23	18 24
25	18 31	15 45	8 55	22 48	17 12	18 26

The preceding numbers will enable any person to find the positions of the planets, to lay them down upon a celestial globe, and to determine their times of rising and setting.

ART. XXIX.—*Summary of Meteorological Observations made at Kendal in December* 1829, *and January and February* 1830. By Mr SAMUEL MARSHALL. Communicated by the Author.

State of the Barometer, Thermometer, &c. in Kendal for December 1829.

	Barometer.	Inches.
Maximum on the 31st,	- - -	30.40
Minimum on the 4th,	- - -	29.55
Mean height, -	- - -	29.93
	Thermometer.	
Maximum on the 7th,	- - .	51°
Minimum on the 28th,	- -	20°
Mean height, -	- -	35.16°

Quantity of rain, 2.899 inches.
Number of rainy days, 6.
Prevalent winds, north east.

This has been a very cold and dry month and, had it not been for the rain which fell on the 11th, 12th, and 13th, on which three days 2.505 inches were measured, we should have had but .249 inch for the month. There have been but six rainy days. Though there have been several days on which snow has fallen, yet when melted the quantity has been scarcely sufficient to be measured by the gauge, amounting altogether only to .145 inch. The barometer has been high through the whole of the month, and the mean is greater than has been the case in any month for several years. The mean of the thermometer clearly indicates the severity with which the winter has commenced. The cold dry winds from the N. E., N. and E. have prevailed during the greater part of seventeen days. The temperature of the days and nights has frequently been nearly equal, sometimes not varying more than 3° or 4°.

January, 1830.

	Barometer.	Inches.
Maximum on the 1st,	- - -	30.47
Minimum on the 21st,	- - .	28.99
Mean height, -	- - -	29.86

Thermometer.

Maximum on the 7th,	40°
Minimum on the 19th,	15°
Mean height,	30.77°

Quantity of rain, .429 inch.
Number of rainy days, 3.
Prevalent wind, north.

In January 1826, the mean height of the thermometer was rather less than the mean for this month; but, excepting this instance, the weather has not been so severe for many years. At that time the thermometer was at 9°, as well as in the following January, but the weather was not so severe through the month. It is now eight weeks since the frost may be said to have begun, since which time (or about the 7th December) the thermometer has rarely been above the freezing point in the nights. Though we have had frequent snow showers during the month, yet they have been trifling. In this respect the county of Westmoreland has fared differently to what most of the midland and southern counties have done. Neither have we had the thermometer so low as appears to have been the case in the south, where it is stated to have been observed as low as 10°. The winds have been in the N. N. W., N. E. and E. all cold quarters for twenty-five days out of the thirty-one. When we have had a strong wind from the N. or E. which has sometimes been the case, it has been most piercing. Of course with all this frost we have had but .429 inch of rain, and but three days on which any has fallen. The Aurora Borealis was splendid in its appearance on the 28th. It has not been observed except on the evening of that day, though it is probable enough it may have occurred frequently without being noticed. In very few months within the last eight years has the mean of the barometer been so great as in this month.

February.

Barometer.

	Inches.
Maximum on the 15th,	30.18
Minimum on the 8th,	28.95
Mean height,	29.66

Thermometer.

Maximum on the 26th,	51.5°
Minimum on the 7th,	19°
Mean height,	34.24°

Quantity of rain, 4.774 inches.
Number of rainy days, 11.
Prevalent wind, west.

The weather in the early part of the month was cold like that of the preceding month, and we had several snow showers. On the 7th, snow fell to the depth of five inches. Since that time it has been mostly mild and genial, though on the 22d snow fell most of the day. We have had more rain this month than for sometime previous. The barometer has been mostly low. The Aurora Borealis appeared on the evening of the 19th, but was accompanied by no streamers that were perceptible.

ART. XXX.—REGISTER OF THE BAROMETER, THERMOMETER, AND RAIN-GAGE, *kept at Canaan Cottage.* By ALEX. ADIE, Esq. F. R. S. Edin.

THE Observations contained in the following Register were made at Canaan Cottage, the residence of Mr Adie, by means of very nice instruments, constructed by himself. Canaan Cottage is situated about 1½ mile to the south of Edinburgh Castle, about 3 miles from the sea at Leith, and about ¼ of a mile N. of the west end of Blackford Hill. The ridge of Braid Hills is about 1 mile to the south, and the Pentland Hills about 4 miles to the west of south. The height of the instruments is 300 feet above high water-mark at Leith. The morning and evening observations were made about 10 A.M. and 10 P.M.

DECEMBER 1829.

D. of Week	Day of Month.	Thermometer. Morn.	Thermometer. Even.	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
T.	1	38	38	38	35	38	36.5	29.70	29.62	
W.	2	39	41	40	35	41	38	29.55	29.52	
T.	3	40	40	40	38	43	40.5	29.52	29.50	
F.	4	43	47	45	37	47	42	29.48	29.57	
S.	5	50	52	51	44	53	48.5	29.78	29.97	
S.	6	53	52	52.5	50	54	52	30.00	30.10	
M.	7	48	30	39	45	51	48	30.13	30.04	
T.	8	35	36	34.5	24	36	30	30.08	30.17	
W.	9	38	38	38	31	42	36.5	30.13	30.03	
T.	10	38	38	38	36	40	38	29.87	29.76	
F.	11	41	48	44.5	35	48	41.5	29.55	29.30	.15
S.	12	50	43	46.5	38	50	44	29.42	29.73	
S.	13	53	44	48.5	41	53	47	29.54	29.80	.16
M	14	43	38	40.5	35	48	41.5	30.00	30.16	
T.	15	35	28	31.5	29	43	36	30.18	30.16	
W.	16	39	30	30.5	24	34	29	30.00	29.85	
T.	17	39	36	37.5	26	39	32.5	29.38	29.39	.02
F.	18	38	31	34.5	34	39	36.5	29.62	29.77	
S.	19	32	32	32	25	34	29.5	29.77	29.71	
S.	20	31	27	29	26	34	30	29.67	29.60	
M.	21	31	32	31.5	25	34	29.5	29.83	29.47	
T.	22	30	31	30.5	27	35	31	29.58	29.55	.47
W.	23	30	34	32	24	34	29	29.89	29.86	
T.	24	38	35	36.5	29	38	33.5	29.95	30.08	
F.	25	34	30	32	24	36	30	30.16	30.22	
S.	26	31	26	28.5	27	32	29.5	30.27	30.23	.40
S.	27	30	28	29	25	30	26.5	30.22	30.18	
M.	28	35	35	35	26	34	30	30.13	30.14	
T.	29	33	33	33	31	35	33	30.29	30.28	.13
W.	30	35	33	34	31	35	33	30.30	30.41	
T	31	34	33	33.5	30	35	32.5	30.49	30.46	
	Sum,	1172	1117	1144.5	985	1245	1115	926.60	926.61	1.33
	Mean.	37.81	36.03	36.92	31.77	40.16	35.97	29.890	29.891	

JANUARY 1830.

D. of Week	D. of Mon.	Thermometer. Morn.	Thermometer. Even.	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
F.	1	31	32	31.5	30	34	32	30.46	30.41	
S.	2	32	38	35	26	38	32	30.39	30.32	
S.	3	38	39	38.5	35	41	38	30.28	30.20	
M.	4	41	40	40.5	35	47	41	30·15	29.96	
T.	5	39	38	38.5	33	41	37	30.07	30.06	
W.	6	44	40	42	35	46	40.5	29.63	29.46	
T.	7	37	33	35	36	43	39.5	29.86	29.95	
F.	8	32	37	34.5	29	37	33	30.03	29.95	
S.	9	40	36	38	27	44	35.5	29.80	29.77	
S.	10	34	35	34.5	32	37	34.5	29.78	29.82	
M.	11	38	34	36	31	39	35	29.68	29.76	
T.	12	35	36	35.5	30	38	34	30.02	30.02	
W.	13	36	30	33	34	38	36	29.96	29.88	
T.	14	34	34	34	27	38	32.5	29.95	29.93	.10
F.	15	35	35	35	32	37	34.5	29.95	29.87	
S.	16	35	32	33.5	31	38	34.5	29.95	29.83	.03
S.	17	35	33	34	29	35	32	29.68	29.68	
M.	18	33	23	28	28	36	32	29.76	29.61	
T.	19	29	29	29	20	32	26	29.43	29.17	.20
W.	20	31	32	31.5	24	33	28.5	29.13	28.95	.20
T.	21	34	34	34	32	36	34	28.94	29.25	.40
F.	22	35	36	35.5	32	36	34	29.50	29.77	
S.	23	34	34	34	32	36	34	29.87	29.70	
S.	24	34	37	35.5	32	37	34.5	29.67	29.76	
M.	25	32	40	36	29	40	34.5	30.07	30.09	
T.	26	38	37	37.5	37	42	39.5	29.95	29.98	
W.	27	37	32	34.5	34	40	37	29.47	29.74	.02
T.	28	32	27	29.5	25	38	31.5	29.97	30.04	
F.	29	36	35	35.5	23	39	31	29.98	29.86	
S.	30	37	35	36	29	38	33.5	29.83	29.82	
S.	31	35	39	36	31	34	32.5	29.81	29.89	
		1091	1072	1081.5	940	1188	1064	925.00	924.28	.95
		35.19	34.58	34.89	30.32	38.32	34.32	29.859	29.822	

FEBRUARY 1830.

D. of Week	D. of Mon.	Thermometer. Morn.	Thermometer. Even.	Thermometer. Mean.	Register Therm. Min.	Register Therm. Max.	Register Therm. Mean.	Barometer. Morn.	Barometer. Even.	Rain.
M.	1	29	30	29.5	27	32	29.5	29.77	29.87	.15
T.	2	31	30	30.5	21	32	26.5	29.82	29.85	
W.	3	31	30	30.5	30	33	31.5	29.95	29.97	
T.	4	31	30	30.5	31	36	33.5	29.87	29.68	.20
F.	5	28	23	25.5	23	31	28	29.55	29.37	
S.	6	24	21	22.5	20	26	23	29.30	28.91	
S.	7	36	39	37.5	18	39	28.5	28.81	28.65	
M.	8	38	37	37.5	33	43	38	28.75	29.07	
T.	9	40	36	38	35	47	41	29.10	29.13	
W.	10	40	33	36.5	31	42	36.5	29.55	29.68	
T.	11	40	44	42	31	44	37.5	29.68	29.55	
F.	12	44	42	43	35	47	41	29.58	29.65	
S.	13	44	42	43	40	46	43	29.73	29.70	
S.	14	43	35	39	33	46	39.5	29.73	30.03	.20
M.	15	33	33	33	28	39	33.5	30.17	30.12	
T.	16	40	38	39	27	47	37	30.03	29.81	
W.	17	42	34	38	36	46	41	29.51	29.49	
T.	18	30	27	28.5	23	33	28	29.45	29.58	
F.	19	32	24	28	24	37	30.5	29.36	29.47	
S.	20	32	31	31.5	23	35	28	29.32	29.08	.20
S.	21	31	30	30.5	22	35	28.5	29.03	29.00	
M.	22	30	31	30.5	17	39	28	29.26	29.26	
T.	23	35	41	38	29	41	35	29.47	29.30	.11
W.	24	46	50	48	39	53	46	29.47	29.54	
T.	25	52	48	50	48	57	52.5	29.62	29.31	
F.	26	52	48	50	47	56	51.5	29.47	29.23	
S.	27	51	44	47.5	44	52	48	29.42	29.46	
S.	28	48	40	44	36	53	44.5	29.62	29.88	.30
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INDEX TO VOL. II.

NEW SERIES.

ABERRATION of a diamond lens, 317
Achromatic object-glasses purchased by Mr South, 181
Adie, Mr, his meteorological observations, 188, 380
Albumen, new principles in, 183,
Aldini, M., his incombustible dresses described, 207
Algæ Britannicæ, analysis of Dr Greville's work on, 360
Allophane, analysis of, 173
Anemometer, account of a new one, 31
Avernus lake, account of, 86
Baja, account of the district of the Bay of, 75
Becquerel, M., on the decomposition of carburet of sulphur by small electric forces, 183
Bertrand de Doue, M., on the fossil bones of St Privat-d'Allier, 276
Berzelius, M., account of a visit to, 189 —on thorina and its salts, 223
Birds of Madeira, Dr Heineken on the, 145
Brewster, Dr, on a new series of periodical colours produced by grooved surfaces, 46
Bromine in English salt springs, 182— atomic weight of, 372
Cagliostro, the juggler, account of, 6
Carburet of sulphur, decomposition of, by small electric forces, 183
Caverns in Tungkin described, 263—of Booban, 268
Celestial phenomena, 188, 376
Chemistry, practical, Mr Reid's work on, notice of, 175
Chromate of iron in Shetland, 374
Clark, Mr James, his new method of cutting screws, 273
Cold, on its action on animals, 111
Colours, periodical, on a new series of, produced by grooved surfaces, 46
Cervus Euryceros, on the history of the, 301
Cuthbert, Mr, his process for working elliptic specula for reflecting microscopes, 321
Cuvier, Baron, his life of Baron Ramond, 1—on the mullets of Europe, 61
Diamond district of Brazil, excursion to the, 241
Diamonds, account of their discovery in Russia, 261
Diamond lens, on the aberration of one, 317
Dutrochet, M., on the effects of light on liquids, 370
Earthquakes in India, 333, their connection with variations of the barometer, 333, note
Elbroutz, account of the ascent of, 134
Electricity and light, on an analogy between them, 232
Faraday, Mr, on the manufacture of Flint-Glass for Achromatic Telescopes, 181, 369
Flint-Glass for achromatic telescopes, experiments on, 181, 368
Flourens, M., on hybernation and lethargy and the action of cold on animals, 111
Forbes, J. D., Esq., on a new anemometer, 31—on the district of the Bay of Baja, 75—on the islands of Procida and Ischia, 326
Fossil Elk of Ireland, history of the, 301
Fossil bones of St-Privat-d'Allier discovered in Basalt, 276
Fumarole described, 347
Galvanism, on the electrical and chemical theories of, 150
Gersuppa, the falls of, described, 129
Greville, Dr, on the Algæ Britannicæ, 360
Grooved surfaces, on the periodical colours of, 46
Hansteen, M., notice of his magnetic journey, 291, 295
Hermaphrodism, theory of Dr Knox's 322
Hibbert, Dr, discovers fossil bones in Basalt in the province of Velay, 276 —on the history of the Cervus Euryceros, 301
Henry, Dr W., on the discovery of magnesite in Anglesey, 155
Henwood, Mr W. J., on the performance of steam engines in Cornwall, 102, 247 —on the discovery of mineral pitch in Cornwall, 374
Himalaya Mountains, on the climate of, 133
Horn Cape, productions of, 26
Humboldt, Baron Alexander, his discourse pronounced at the Academy of St Petersburg, 286
Hybernation of animals, 111
Incombustible dresses of M. Aldini described, 207
Insects, history of, in the Family Library, No. 7, analysed,

Iodine in English salt springs, 182—atomic weight of, 372
Ischia, Mr Forbes's account of the Island of, 326
Isogeothermal lines, account of the, 251
Johnston, Mr J. F. W., account of his visit to Berzelius, 189
Knox, Dr, his theory of hermaphrodism, 322—of the respiratory organs, 325
Kupffer, M., his ascent to Mont Elbroutz, 134—on isogeothermal lines, 251
Lethargy of animals, 111
Light, its effects on liquids, 370
Lizards, notice of their appearance in unusual circumstances, 183
Magnesite discovered in Anglesey, 155.
Magnetism of the solar rays, 228.
Marianini, M., on an analogy between electricity and light, 232.
Marshall, Mr S. his meteorological observations at Kendal, 186.
Matteucci, Charles M., on the influence of electricity on animal putrefaction, 230
Melanorrhœa usitata, on the new genus of, 66
Metals, researches on the structure of, as indicated by their acoustic properties, 104
Meteor seen at Plymouth, 371
Meteoric iron, notice respecting, 371
Meteoric stone, analysis of, 373
Meteorological observations at Kendal, 186—at Canaan Cottage, 188—in the Isle of Man, 249
Microscopes, reflecting, on elliptic metals for them, 321
Mineral pitch discovered in Cornwall, 374
Mineral water of Ronnely, 371
Mirage in Central India, 268
Monte Nuovo, account of, 79
Mullets of Europe, Baron Cuvier on the, 61
Naples, physical notices of the Bay of, 75, 326
Nitrate of silver, reduction of, 371
Oxmantown, Lord, on large reflecting telescopes, 136
Oxygen in lithia, 182
Patents, list of English ones granted since 1675, 43—list of Scottish ones, 375
Physical geography, contributions to, 129
Pritchard, Mr, on the aberration of a diamond lens, 317
Procida, Mr Forbes's account of the island of, 326
Putrefaction in animals, as affected by electricity, 230
Ramond, Baron, life of, 1
Reid, Mr D. B., his work on practical chemistry analyzed, 175
Respiratory organs, Dr Knox's theory of, 325
Riess and Moser, MM., on the magnetism of the solar rays, 225
Ritchie, Mr W., on the theories of galvanism, 150
Rohan, Cardinal de, anecdotes of, 5
Ronnely, mineral water of, 371
Russia, account of the scientific researches lately carried on there, 286
Savart, M., his researches on the structure of metals, 104
Scott, Alex. Esq., account of his new steam engine, 21
Screws, method of cutting, by Mr James Clark, 273
Ship-building, analysis of the article in the Edinburgh Encyclopædia, 163—355
Siamese twins, account of, 122
Society, Cambridge Philosophical, proceedings of, 180—Society, Royal, of Edinburgh, its proceedings, 177—Society of Arts for Scotland, proceedings of, 177
Spectral illusions, account of a remarkable case of, 218, 319
Spix and Martius, MM., their excursion to the diamond district of Brazil, 241
Staten Island, productions of, 26
Steam engines in Cornwall, account of their performance, 102, 247
Steam engine, account of a new one without a boiler, 21
Steam, on its use in destroying vermin in ships, 157
Telescope of Dorpat, dispute respecting it, 182
Telescopes, reflecting, account of Lord Oxmantown's experiments on, 136
Temperature of the ground as ascertained by springs, 251
Thorina and its salts described, 223
Tod, Colonel, on the mirage in Central India, 268
Tungkin, cavern in described, 263
Turner, Dr E. his chemical examination of wad, 213—on the Atacama iron, 371
Twins, Siamese, account of, 122—another case of united twins described, 374
Varnish tree, on the Burmese one, 66
Vermin in ships, method of destroying them by Steam, 157
Volcano in Australasia, 270
Wad, chemical examation of by Dr E. Turner, 213
Wallich, Dr, on the Burmese varnish tree, Melanorrhea usitata, 66
Webster, Captain, on the productions of Staten Island and Cape Horn, 26

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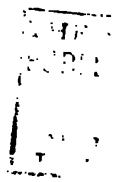

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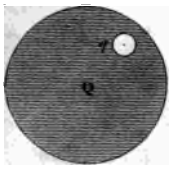

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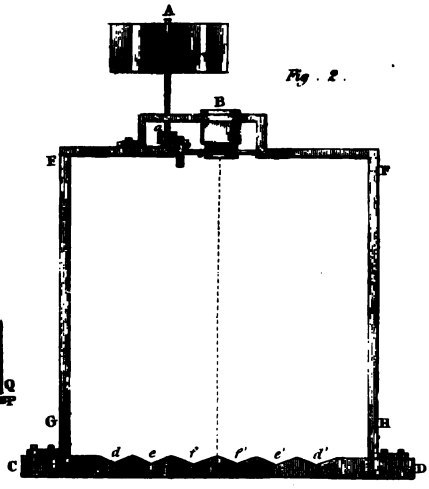

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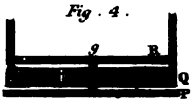

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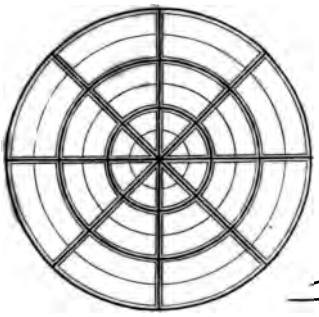

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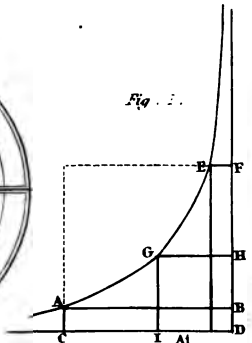

Fig. 13.

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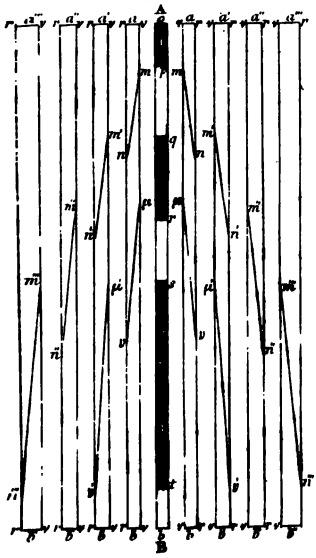

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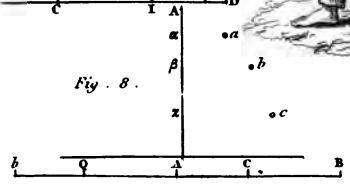

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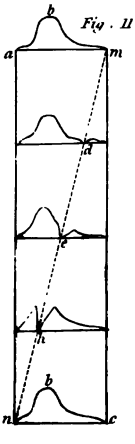

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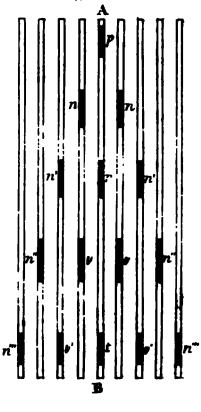

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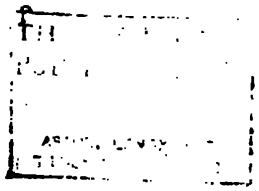

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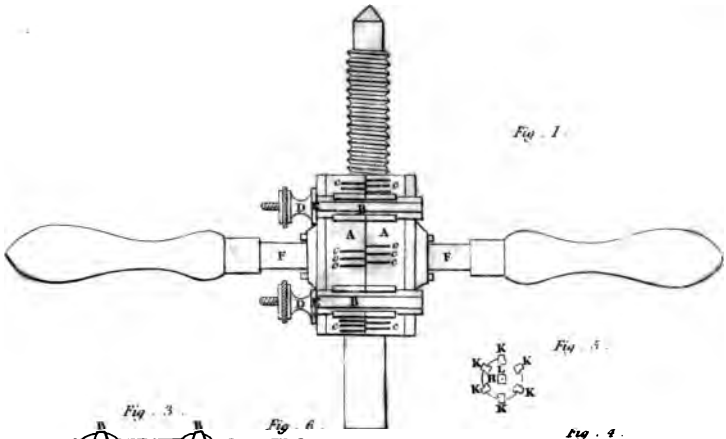

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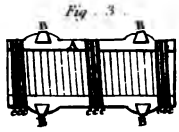

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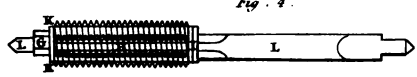

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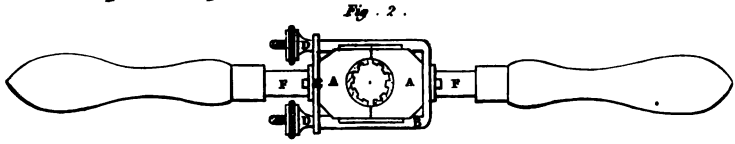

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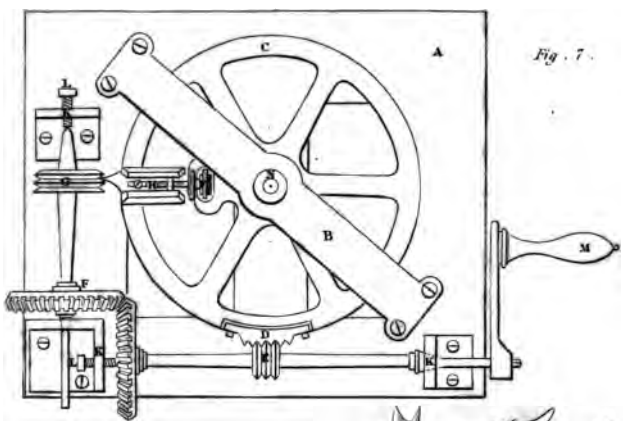

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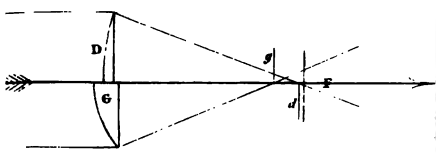

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